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THE Association was organized in Boston, Mass., on June 21, 1882, with the object of providing its members with means of social intercourse and for the exchange of knowledge pertaining to the construction and management of water works. From an original membership of only TWENTY-SEVEN, its growth has prospered until now it includes the names of 800 men. Its membership is divided into six classes, viz.:

A Member shall be an officer or employee of a public or private water works, an engineer, chemist or other person qualified to aid or interested in the advancement of knowledge relative to water works.

An Honorary Member shall be a person of acknowledged eminence in some branch of water supply or of engineering.

A Junior shall be not less than eighteen years nor more than twenty-five years of age, a student or connected with water supply work.

An Associate shall be either a person, firm or corporation engaged in manufacturing or furnishing materials or supplies for the construction or maintenance of water works.

A Corporate Member shall be either a Water Board, Commission, Company or Municipal Corporation.

The initiation fees and annual dues are as follows:

	Initiation Fees		*Annual Dues*
Members	$ 3.00	Members	$ 6.00
Juniors	1.00	Juniors	3.00
Associates	10.00	Associates	20.00
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This Association has at least eight regular meetings each year, of which five are held in Boston, one in northern New England, one in southern New England, and one, the annual convention, held in September on such date as the Executive Committee may designate.

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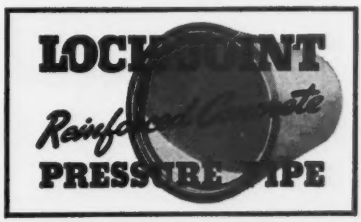

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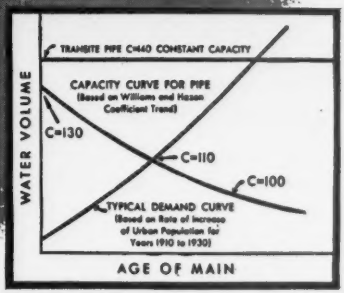
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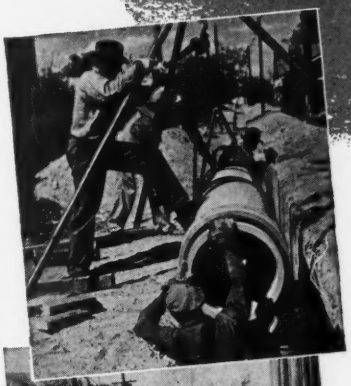

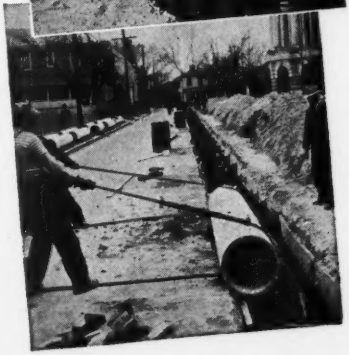

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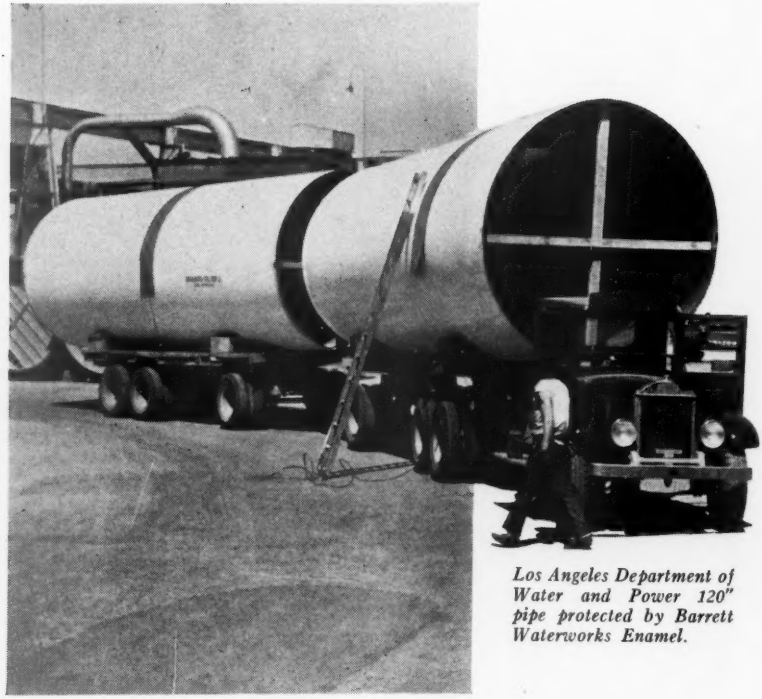

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New England Water Works Association
ORGANIZED 1882

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This Association, as a body, is not responsible for the statements or opinions of any of its members

LAWS GOVERNING WATER UTILITIES

BY DAVID E. MOULTON*

[*Read September 19, 1944*]

UNDER present conditions, with Congress and our State Legislatures passing new and radical laws, and the courts abandoning precedents that have stood for years, it is a rash individual who would pretend to tell what the law is. This paper will, therefore, be more of an analysis of the sources of our laws and a discussion of their principles than a positive statement as to the laws themselves.

What do we mean by law? We have selected the following definition as best adapted to this discussion: "Law is a rule of action prescribed by a superior that an inferior is bound to obey." You will be surprised to learn how many such governing superiors we have.

In the collection and distribution of our water supplies, we are governed by the laws of nature, from whose edict there is no appeal. We are sure that when the temperature is low enough water will freeze and, when the elevation of the source is high enough, there will be adequate pressure. If we were only governed by the laws of nature our lot would indeed be a pleasant one. Unfortunately this is not the case, and the modern public utility is about the most governed industry in an over-governed age.

In England, and here by adoption, the laws that govern our daily transactions are the evolution of those rules of social conduct which, though never formally adopted by any legislative body or assembly of citizens, have been recognized by the Courts of England as founded upon the principles of righteousness and good conscience and are generally observed as such, and, if not so observed, the violator is subject to Court procedure.

This is known as the Common Law of England. It is founded

*Attorney, Portland Water District, Portland, Maine.

upon customs so old that "the memory of man runneth not to the contrary," and it becomes a "rule of action" to govern our conduct when those principles are recognized and declared by the Court as such.

Many of the principles of common law were so revered by our forefathers that they were incorporated into the constitutions of our states and a Supreme Court was created to whom was entrusted the duty and power of preventing encroachment thereof. In England, however, acts of Parliament become the law of the land when properly enacted and are not subject to appeal to the Courts.

The English practice has been recommended in this country by no less a personage than the first Roosevelt, but it was his proposal to accomplish the same by constitutional methods. The other, later, Roosevelt, however, accomplished the same result by the simple expedient of appointing to the Supreme Court men amenable to his wishes. Theoretically, we still have a constitutional government, but practically the will of the law-making bodies seems unrestrained, and the last few years have seen tremendous changes in the government and control of public utilities. This trend should be recognized. If Congress and our legislatures insist upon passing laws inimical to our constitutional rights, that end will eventually be accomplished. Even courts cannot be expected to forever protect fools from their folly. Many of these legislative acts, however, are simply declaratory of the common law, and its general principles still govern our daily transactions.

Under the common law, it was early recognized that industries especially affecting the public welfare should be regulated and assume burdens not incumbent upon ordinary business concerns, not so affected. A grocer, for instance, could select his customers, while one carrying on a business affected with a public interest did not have this freedom of choice but must serve all who applied, without discrimination. Public utilities were always considered to be in this class, and, in their case, duties and obligations were recognized, resting in no sense upon an agreement or contract but entirely upon the relation existing between the parties. It being the duty of a utility to serve all who applied without discrimination, no contract therefor was considered necessary, or even permissible, as its only effect would

be to allow something differing from the common practice and, therefore, discriminatory.

The first law under which we are governed, therefore, is the common law requirement that, when in business charged with a public interest, we are under legal obligations to parties, whom perhaps we have never seen before, who can demand of us a service, often in an insolent manner, to which we must submit up to the limit of our endurance. We have dedicated our investment and our service to the public and can no longer choose our customers or grant favors to our friends, nor can we fix the amount we charge for our product, nor the hours we are to work. While as a corollary to these obligations the common law does permit us to adopt rules and regulations governing our relations with our customers, they are always subject to the burden, in case of dispute, to show that such rules and regulations are reasonable.

In the early development of the common law, this power to regulate was justified on the ground that the business was different, in that the public had an interest therein, not common to other industries. Later it was sustained on the ground that utilities operated under a franchise from the state or were exercising a monopoly, and that these facts entitled the state to regulate them.

Now the Supreme Court of the United States has flatly abandoned all these reasons and says:

"Any and all industry is subject to control and regulation under the police power of the state. If one embarks in a business which public interest demands shall be regulated, he must know that regulation will ensue; that the activities of railroads and all business units supplying transportation or heat, power and water to communities so nearly touch the vital economic interest of society, that the police power of the Court may be invoked to regulate their charges, and no formula of affectation or clothing with a public interest is necessary to justify the regulations. The touchstone of public interest clearly is not the enjoyment of any franchise from the state nor is it the enjoyment of a monopoly. There can be no doubt that on proper occasion and by appropriate measures the state may regulate a business in any of its aspects including the price to be charged for its products or the commodity it 'sells.' "

"With the wisdom of the policy adopted, with the adequacy or practicability of the law enacted to forward it, the Courts are both incompetent and unauthorized to deal. Any form of regulation is unconstitutional only if arbitrary, discriminatory or demonstrably irrelevant to the policy the legislature is free to adopt, and hence unnecessary and unwarranted interference with personal liberty."(1)

It is evident from this decision of the highest court of the land that public utilities can look for no lessening of regulations but must be reconciled to other and further control of their actions, within the limits above provided.

A question naturally arises whether our municipalities and other political subdivisions of the state, exercising governmental powers, are also subject to these regulations if *they* undertake to supply water to their inhabitants. It seems that there is no difference between a municipality and a private water company engaged in the same business, as the Court says in a recent case: "It is no part of the duty of a municipal corporation to engage in a purely business or commercial enterprise. When it seeks and obtains from the legislature permission to engage in such an enterprise, its act in so doing is entirely voluntary on its part, and, while engaging in such business, it is acting in a purely private capacity, outside of its functions and duties as a municipal corporation and is bound by all of the rules of law and procedure applicable to any other corporation or person engaged in private enterprise." (2)

It follows that the ordinances of a municipality engaged in furnishing water, prescribing regulations for the same, has no greater force than the by-laws of a private corporation enfranchised to do business of a like character, since both stand upon the same footing and have exactly the same right to make and enforce reasonable rules and regulations. (3)

Or as another Court states: "A municipality in furnishing water to its inhabitants is acting in a corporate and not in a governmental capacity." (4)

Dillon, the great authority on municipal law states:(5) "The dual capacity or twofold character possessed by municipalities is governmental, public, or political, and proprietary, private or quasi private. In its governmental capacity a city or town acts as an agency of the

state for the better government of those who reside within the corporate limits, and in its private or quasi private capacity, it exercises powers and privileges for its own benefit."

As the state cannot be used or held responsible for its acts, along with these governmental duties goes an immunity to the municipality for the neglect of individual officers of the municipality while performing such duties. This creates a very fine distinction between governmental functions and ordinary business, especially when the same individual may be engaged in both duties under the same employer. It is universally held that management of a fire department is governmental as is also the maintenance of law and order. But suppose, for instance, that the same man acts as chief of the fire department and perhaps holds other offices which are governmental and at the same time happens to be manager of the city water department, which under the above rule of the Court is only a commercial enterprise. If he as chief of the fire department disregards the law and negligently injures an innocent bystander while going to a fire, the city would not be liable as he would be deemed to be exercising a governmental function of the state. Yet, if, in the same vehicle and under the same circumstances, he was acting as superintendent of the water department, the city would be liable for his acts.

Interesting questions have also arisen as to the power of the regulatory commissions to pass upon the reasonableness of rules and regulations and of rates charged by a municipal water department. There are states where the courts have held that the statutes do not give authority to the regulatory body to interfere with municipally owned plants, and of course the power of the commission depends entirely upon the statute which created it. Most states do give them authority over both municipal and privately owned and managed utilities.

It is interesting to note, however, that even if the regulatory commissions have no statutory authority over these utilities, the common law is still in force, and under it the *courts* have power to pass upon the reasonableness of rates charged by a municipality. In a late case in Pennsylvania the Court said: "A city operating its own water works acts as a private corporation and not in its sovereign capacity. *Courts* have the power to determine questions relating to

the service and rates of a municipal water works where a complaint is based on the *reasonableness* of the established rates or the *justness of their application,* or *discrimination amounting to confiscation,* although the municipal plants are not subject to control under the Public Service Act."

Another difference in favor of municipal plans is in the treatment of accumulated depreciation and adequate charges therefor. It is a general rule that a *private utility* may not charge its customers excessive rates for current services because it failed to charge adequate rates for past services. Yet, the *courts* hold that a public municipal corporation serving itself may omit all depreciation charges from current rates and later require its customers to pay for both current and past depreciation through higher rates, or even cause a tax to be levied and thus cause the property owners to make good the past depreciation. (6)

By this time you will note that we are subject to laws and regulation by:

1. The Common Law of England.
2. Legislative acts of the various states.
3. Rules of state regulatory commissions.
4. Rules and regulations adopted by the utility itself under its common law power so to do.
5. Acts of Congress and rules and regulations of the many bureaus to whom it has delegated authority, like the Department of Labor or Commerce.
6. Supplementing these are always the terms of the franchise creating the utility and the laws and ordinances of the local political subdivisions of the state where the utility operates, under powers delegated to them, such as control of streets, etc.

Let us consider them briefly:

Common Law Requirements. We have seen that under the common law a water utility is liable in case of failure of service, not because of a breach of any contract with the water taker, for indeed there was or should be no such contract, but because it *owed a duty to the water taker which it had failed to perform.*

This is the law today unless the utility has needlessly increased its responsibility by contract with the water taker, enlarging its common law duties.

If then the duties and responsibility of the utility depend upon the *relation of the parties,* it is necessary to know when that duty begins.

When does a customer become entitled to this service? It being our duty to serve all who apply without discrimination, the first requisite is a set of rules and regulations to govern our relations with our customers, and the common law empowers us to adopt such as we desire, subject always to the burden of showing them to be reasonable.

Naturally, the first thing required is the name and address of the party who desires the service, the nature of the service, and when and where desired. Consequently, we have the right to demand a written application signed by the prospective water taker, or his authorized agent, giving this information. No advantage can be taken of him by attempting in this statement to enlarge his obligations. Even a promise to pay or to observe the rules and regulations would not enlarge his obligation so to do, nor would waiver of damages due to negligence of the utility relieve the utility therefrom. All of these are established by the common law, and the written application is simply to furnish the utility with the necessary information as to what is required of it.

It will be noted that we do not undertake to sell water as merchandise is customarily sold. In fact, ours is not really a sale of water, which is free to all, like the air we breathe, but only in its original location. Our business is to collect and transport it to the locality desired. Nor do we undertake to serve a particular individual. It is the locality or *structure served* that is the *unit of service, not the individual* demanding the service. Our business, by its very nature, is restricted to the location of our mains, and we simply undertake to deliver water through them to a particular point for the *service* of a *definite* and *fixed* structure, the ownership of which may and often does change. The application for service fixes the location and defines the structure to be served.

It is not until the structure is ready for service and the owner has brought the service pipe to the street line where there is an exist-

ing main that there is any *present* duty owed the water taker. If there is no existing street main at that point, it becomes a matter of discretion on the part of the utility whether or not to make the necessary extension.

This matter of *undertaking service* by a utility is of extreme importance as its legal duties are thereby established and *once the service is undertaken it must be continued.* The court has even held that a water utility that undertook, for the accommodation of a customer, to supply winter water through a surface pipe on the chance that it might not freeze was bound to continue the service and install winter pipes through ledge when the experiment proved unsuccessful, regardless of the extraordinary expense involved. We should be careful therefore not to undertake to furnish a quantity or quality of service that unnecessarily increases our obligations.

A water utility can of course agree to do anything not *ultra vires,* if it is unwise enough to do so, but it will get no sympathy from the courts if it gets into trouble thereby. The law imposes no duty on a water utility to do work on private property, and if it does undertake the same and is not paid therefore it has no more rights than any contractor. It can refuse to furnish water until a current water bill is paid, but this power cannot be extended to assist in collecting bills for outside work, unnecessarily undertaken.

All service by water utilities is now supposed to be furnished in accordance with established rates, rules, and regulations filed and published as required by law, and any variation therefrom without the consent of the commission is discriminatory and consequently illegal.

As it is the duty of the consumer to provide equipment for the structure, the utility cannot dictate the nature of such equipment, and this is entirely within the control of the consumer, subject only to the condition that nothing can be installed that may injure the public supply. As the *unit of service is* the *structure supplied,* it makes no difference who occupies it, whether tenant or owner. Legal possession gives the occupant the right to demand the service. There may be situations where a rule might be held reasonable, restricting service to owners, but such is not generally accepted as the law. This unit of service explains why service cannot be denied a new occupant by

reason of unpaid water bills by a previous tenant. Nor can water be shut off in *one structure because* the water taker owes a bill at *another location.*

The duty to serve, however, does not require the utility to turn on the water unless payment is made in advance. To give credit that may result in failure of payment is discriminatory. All water bills are supposed to be paid, and it is the duty of the utility to see that payment is made. This it can do by collecting in advance or requiring a deposit from parties who have not established a credit. If credit is given, however, and the bill is not paid when due, service may be discontinued until the bill is paid, but should a new occupant demand service at the same structure such service cannot be denied. If credit is given and the service continued with an old bill still delinquent, it is no longer possible to deny service to compel the payment of the old bill, if the customer tenders payment in advance for the current service. Nor is this right to deny service available to the utility to enforce payment for work done or materials furnished outside of its duty "charged with a public interest." For example: a water utility not being required to do work on the owner's premises or to supply labor and material therefor, such work in no way being charged with a public interest, it cannot refuse to supply water if these bills are not paid. It has no superior right to any other contractor or plumber who might have done the work and supplied the materials. It was not obliged to do the work and, by doing the same, placed itself in the same position as any ordinary contractor.

In some cases, as where an extension is asked for, involving a considerable investment, and the return therefrom is dependent largely upon hydrant rentals, it is permissible with the consent of the commission to make a contract for a term of years by which the utility is guaranteed such rentals. Otherwise, the municipality could discontinue at will its hydrant service with consequent loss of revenue to the utility.

Where service can be furnished from existing mains no contract in variance of the established rate is necessary or permissible.

In Maine our Commission refused to approve a contract with a town for service for a definite term where the town could get efficient

service at reasonable rates without a contract and the service did not require any substantial addition to the plant.

The service that must conform to established rates refers solely to that service which the utility is rendering under its charter and "charged with a public interest." When the utility undertakes, as it often does, to do work on private premises for the convenience of those customers, it is then considered as doing an ordinary business like any plumber or contractor and is governed by the general law of the state.

The same distinction exists in the incidental business of supplying equipment. As the Illinois Commission states "it has no jurisdiction over the prices charged by an electric company for merchandise sold to its customers nor for charges made for wiring houses." A similar ruling was made in New York where the commission said: "The furnishing and sale of gas ranges is not a duty imposed by law upon gas companies and no power has been conferred by the legislature upon the commission to regulate an undertaking by the company of that business. Unless the acts of the gas company in respect to appliance business affect the performance of its duties imposed by law, and which the commission has power to regulate, the commission would not now be authorized to interfere with the acts and practices of the company. (7)

Should contracts be made for supplying water at other than published rates, they are always made under the implied if not expressed conditions, that if future conditions should change so that the contract if continued would be against public policy, the terms of the contract may be reviewed by the Public Utilities Commission at any time and set aside or adjusted to overcome the objections.

A common example of this is the revision sometimes made of long term hydrant contracts. The utility and a city may mutually agree for the furnishing of water at a fixed price for a term of years, such contract being fair and equitable to both parties when made. Should, however, war or some other factor very greatly increase the cost of service, so that it is no longer possible for the utility to provide the service except at a loss, the commission, on finding these facts, would be justified in setting aside the contract and requiring the taker to discontinue the service or to pay adequate hydrant rentals. It is con-

trary to public policy for the present water takers, under the guise of a contract, to secure service at less than cost, to the detriment of future water takers.

A somewhat similar case arises where a utility is ordered to change the location of an existing street main. Even though the utility has gone to great expense in excavating ledge and in the location designated by the municipal authorities, it acquires thereby no vested right to the location. It is a mere licensee, and if the proper officers in charge of the street find it necessary or convenient to change the grade or make some other public improvement such as a sewer, under the police power the state has a superior right to the utility which must at its own expense change its location or even entirely vacate the street.

Nor can this superior right be bartered away by contract with the utility, for no board of municipal officers can prevent a future board from exercising its rights and performing its public duty.

Even in the absence of regulations by the state, utilities are subject to the common law rule that they cannot exact more than a reasonable compensation for the service rendered, and, in case of a controversy as to what constitutes a reasonable rate, the courts have jurisdiction to determine the matter.(8)

Liability for Negligence. By undertaking to supply water as a public utility, the water company, public or private, assumes a duty to the public ***without any contract*** to furnish adequate service at fair and non-discriminatory rates. It must use reasonable care in all cases, but it is not an insurer, either as to the quality of water or the safety of its mains and reservoirs. The degree of care required in all cases depends upon the circumstances and must meet the standards of good practice as required by the hazards involved. High pressure should not be placed on mains not designed for such pressure with a reasonable margin of safety. If pipes of insufficient strength are used and damages follow, the utility would undoubtedly be liable, but liability does not follow just because a main breaks. Negligence in original construction or maintenance, on the part of the utility, must be shown.

The same rule applies to the quality of water furnished. It must use a high degree of care in regard to the supply and its protection at all times. It cannot be held in damages for chance pollution involving

no negligence on its part. In other words, it does not warrant the water to be pure, but it assumes the duty to use all reasonable precautions to see that it is safe. This, undoubtedly, calls for constant supervision and the use of all safety appliances and treatment that is customary under modern sanitary usages.

While water companies are not insurers and are not held to absolute liability for the purity of the water supplied, the cases do go far enough to hold a water company liable for negligence if the water supplied is really dangerous. The duty is to use due care, and that means the highest degree of care.

Extensions. The public duty which a water company assumes when it accepts a franchise and undertakes to supply a municipality and its inhabitants is not limited to the making of service connections in streets in which it has already located mains but requires the company to extend its system into such new territory as the reasonable needs of a growing community demand.(9)

The U. S. Supreme Court in sustaining a commission extension order said: "Corporations which devote their property to public use may not pick and choose, serving only the portions of the territory covered by their franchises which it is presently profitable for them to serve and restricting the development of the remaining portions by leaving their inhabitants in discomfort without the service which they alone can render."(10)

More exactly it may be stated that a public utility must make all *reasonable* extensions. The duty is not absolute, but is conditioned upon the reasonableness of the demand (11). An expenditure by a water company involving an additional burden on the rate payers as a whole, should not be imposed for the benefit of a particular portion of the community, unless a reasonable necessity for it exists. (12) Inadequacy of rates is no defense against making an extension where the company has ample remedy to secure reasonable compensation for the service.(13) Extensions should be curtailed because of war and refused where such refusal is necessary for the conservation of raw material, capital and labor. The needs of war must be given precedence over those of private consumers of public service.(14)

Authorities disagree as to the duty to make extensions in ungraded and unaccepted streets. In Pennsylvania, a water company is

not required to extend its service until the street has been graded, but in New York the contrary has been held and extensions required in a private street neither graded nor accepted by the municipality. (15) The test is not whether the given extension will of itself return a profitable income, but whether the business in that district as a whole, including the contemplated extension, will pay a sufficient return.(16)

Our Maine Commission has held: "An obligation exists upon a utility to fully saturate its territory. It cannot select the profitable part and ignore the unprofitable." (17)

Power of the commissions to order extensions in proper cases is unquestioned. It has been held, however, that a commission cannot establish *general* rules and regulations governing the extension of water mains in a new locality since the necessity therefor must be determined from the facts in each case.(18)

While the court will not substitute its judgment as to what extensions are reasonable, for the determination of the commission, it will consider the investment required and cost of service, and if it appears that the power to regulate passed beyond the exercise of reasonable judgment and amounted to an infringement of the right of ownership, the order will be held invalid.(19)

It is reasonable for a water company to require a guarantee of a reasonable return from a proposed extension, when it is doubtful if the financial condition of the company will warrant the expenditure.(20)

The question may arise as to a credit to the account of customers, guaranteeing a minimum revenue, when further extensions are made of the same main. The New Jersey Commission refused to order such credit.(20) The New Jersey Commission said that it would require that applicants who insist upon an extension at advanced prices during war times, pay the necessary increase to cover the unusual costs the utility incurs.(21)

Extensions of water mains should be made at the expense of a company into territory where these extensions will apparently develop sufficient business to warrant the company in making the necessary investment.(22) Whether a utility should require a contribution toward the cost of an extension to serve a customer, is not a question

between that consumer and the utility, but a matter between the applicant and the consumers who are being served at a lower capital cost than it would cost to serve him. It is to the interest of consumers to keep the capital cost as small as possible, in order that the rates may be as low as possible.

In accordance with this principle, our Cumberland County Power and Light Company was allowed to require the extraordinary cost of serving a particular group, demanding service, to be borne by that group.(23) A municipal water plant should not be required to extend service to applicants who are unwilling to participate in the cost, if the cost of the extension is clearly out of proportion to the revenue which will be derived from the present applicants.(24)

A water company should notify an applicant for service that an extension would be necessary to serve him and afford an opportunity to him to contribute to the cost if necessary in order to afford him the service.(25)

A utility cannot require contribution from a customer it is already serving as a condition precedent to furnishing him additional service of the same kind on the theory that the demand is beyond the capacity of existing facilities, since it is the duty of the company to provide adequate facilities without discrimination for supplying the service requirements of consumers.(26)

A city should be allowed wider discretion in determining the conditions under which its extensions of water service will be built than a privately owned utility, inasmuch as the former is presumably under the control of and representative of the public.(27)

These are a few of the principles of the common law which have not been changed or have been confirmed by legislative acts creating the regulatory bodies. It is impossible to mention all the requirements of the common law in the space allotted to this paper.

A good example of the way the law comes into action and lays down a "rule of action" that must be observed is the fixing of the respective rights of the utility and the water taker in the matter of rates.

Under common law, a utility is entitled to a reasonable return on its property, and the water taker is as equally entitled to reasonable service and at a fair rate. Up to the time of the Brunswick

Water District case here in Maine, the question had never been decided as to which of these co-existing rights was the superior. Our Maine Court there laid down the law, which has since been approved in other states, that the right of the consumer was the greater and he could not be charged more than the worth of the service to him as an individual, even though such a charge failed to produce a fair return to the utility. You will note that the court did not legislate nor profess to lay down a new law. It simply assumed that such had always been the law and when the question arose it was so decided. This is common law, and of course, it may be and often is altered by legislative enactment.

For instance, we have learned that a water utility may adopt a rule or regulation authorizing the discontinuance of the water supply where the water rates are not paid. Yet our Massachusetts friends will point to court procedure enjoining such action. The answer is that by law in Massachusetts the utility has a lien on the property for all water furnished the premises and can collect the amount due by appropriate process. If the shutting off of water supply involves hazards to the public health on account of sanitary conditions, another "rule of action" promulgated by the health authorities may intervene, to the effect that public health cannot be endangered. It is not taking property of the water company without due process of law where it has such a lien to deny the utility the right to discontinue the supply. In Maine, where there is no lien on the property for water rates, to compel a continuation of the service under such circumstances would amount to an illegal taking of property.

While we have not touched upon all its requirements, it is hoped that this analysis of the principles underlying the common law will be of assistance to the water works officials who are so vitally concerned in their operation.

Legislative Acts and Rules of State Regulatory Commissions. Under our system of government divided between the executive, legislative and judicial departments, each of which is forbidden to interfere with the power of either of the others, there is a marked distinction between the powers of the courts and the regulatory commissions.

Judicial powers alone are vested in the courts. Commissions exer-

cise legislative powers delegated to them by the legislature, and as the Legislature itself could not perform the function of the judiciary, it cannot delegate such power to the commission.

The question naturally arises as to the distinction between a judicial and a legislative act. A judicial decision is always concerned with transactions already accomplished and determines what the governing law is at the moment. On the other hand, the commission legislates or prescribes a course of action for the future. A court investigates, declares, and enforces liability under existing laws. That is its purpose and its end. Legislation on the contrary is for the future and makes changes in existing conditions by making new rules to be applied thereafter.

Commissions must take the law as they find it. The question of its constitutionality is not for them, but for the courts. Neither will the commission undertake to interfere between individuals or to enforce private contracts. "Its sole function is to *regulate public utilities* and compel the performance of *their duties to the public*, not to require them to carry out their obligations to individuals." Nor is it any function of a commission to construe contracts or to assume jurisdiction to settle disputes between the utility and its customers, nor to fix the damages resulting from discontinuance of service. All of these questions are entirely of a judicial nature.

It may be stated as a general rule that the commission's regulatory powers are not affected by legal controversies between the utilities or their patrons. While the commission cannot settle or adjust such disputes, it has jurisdiction to order service to continue, pending legal determination of such controversies.(28)

A commission having jurisdiction to investigate the propriety of all rates, should not allow discrimination between customers. This, although no statute or law, specifically prohibits discriminatory rates.(29) But not every discrimination is illegal, for a rate may be discriminatory and yet not unjustly so.(30)

Most states now have laws which are mainly declaratory of the common law that public utilities shall furnish service that is safe and adequate and in all respects just and reasonable. To the commission is delegated power to determine what is proper service and to make and enforce any necessary order, rule, or regulation with

reference thereto. Under such delegated authority, commissions have established standards of electric and water service. Under such statutes, the power of the commission is very complete. Service and rates are, however, closely related. Adequate service can only be required in case of a proper return. Where the return is sufficient, the power to compel adequate service is undoubted.(31)

To sum the matter up: Commissions have extensive, but not absolute, powers over public service companies. They usually have full authority to require adequate, fair, and non-discriminatory rates, and they cannot assume entirely the functions of ownership but may control managerial policies in so far as these policies affect service or rates or any duty or obligation of the companies in respect thereto.(32)

"The duties of a Commission, under the law and the guiding decisions of the courts, are not to be performed by its assuming managerial control over public utilities, nor by substituting its judgment for theirs in the performance of those things which, for the public benefit, the law holds these utilities responsible. The line of demarcation is where the utility is exercising its initial responsibility in a way that adversely affects the public. The commission should exercise care that it does not relieve utilities by its orders of a managerial duty which they ought to perform, and of a responsibility which, if they are to function properly in public service, must continue to be theirs."(33)

As to the limit of the regulatory powers of the commission: Under pretense of regulating, the commission cannot require a utility to serve without reward; it cannot do what, in law, amounts to taking private property without due process of law.

In *Attorney General vs. RR* 160 Mass. 77, the principle is well stated: "An Act which deprives a carrier of a reasonable rate of compensation for services performed, takes its property as much as one that deprives it of real estate." The courts uniformly hold "the power to regulate is not the power to destroy."(34)

Rates which do not amount to confiscation and yet are so low as not to permit a reasonable return, if fixed by the legislature itself, in the absence of confiscation cannot be interfered with by the courts. On the other hand, when the legislature has delegated the rate making

power to a commission and has limited its power to the fixing of *reasonable rates,* the courts do have the power to pass upon the question whether an order of the commission *is* reasonable or unreasonable.(35)

Notwithstanding, the courts have power to set aside a rate as confiscatory or unreasonable, they cannot usurp legislative authority and *fix rates,* as that would be the exercise of the legislative power (36). Prescribing rates for the future is a legislative and not a judicial act.

An appeal always lies to the court from the decree of the commissions exercising delegated powers, as these are legislative acts and can have no more authority than an act of legislature. Even *if the legislation fails to provide for an appeal* it will not *prevent access* to the court, by proceedings directed against the members of the commission.(37) Such appeals, however, lie only to questions of law and not to findings of fact and are limited "to the extent of the unlawfulness of such ruling or order." The burden of proof is always upon the appealing party to establish the invalidity of an order.(38)

Rules and Regulations. The creation of a public utility commission does not deny to public service corporations the common law right to make regulations nor vest such power in the commission, in the first instance; but the commission may on finding such regulations unjust, unreasonable, insufficient, or unjustly discriminatory annul them and substitute others for them.(39)

A public utility has the right to prescribe and enforce reasonable rules and regulations for the government and use of its property, and no such rule should be abrogated by the commission, unless it is contrary to the laws of the state, or is clearly proven to be unjustly and injuriously discriminatory, or so arbitrary and unreasonable as to be decidedly unjust to its patrons. The mere fact that such rule is not the best possible rule is not alone sufficient to bring it within the prohibited class.(40)

Rules of public utilities are presumed to be reasonable, and the burden of proof is upon those who challenge them.(41) The power to make regulations possessed by those who conduct a public utility is part of that right of management of their business which the law concedes to remain in them. Without regulations a company may re-

fuse to accede to a particular request but it does so under peril of showing the particular request unreasonable, whereas if it has a general regulation covering the situation, service may be refused to anyone notwithstanding in *his particular* case it works hardships unless the *whole rule* is shown to be unreasonable.(42)

Generally, regulations are not binding unless due notice has been given. That is, such notice as fairly affects the patrons and requires action by them. Regulations that only affect the employees of the company and govern their actions need not be published.(43)

The essential elements of valid regulations are: Those promoting *public* service are valid; those inconsistent with public duty are void.

Many of these things could be accomplished without regulation, but in close cases the existence of a regulation will turn the scale. For example, smoking or spitting cannot be forbidden without a regulation.

Regulations must not be pressed so far as to be unreasonable. One providing that an agent of the gas company should have free access to the premises at all hours for examining appliances was held to be outrageous.(44) A Tennessee case held a customer was justly cut off from a water supply for letting the water run, although he offered to prove it necessary in order to get the water fresh.(45) Some cases hold that a rule requiring those whose water supply has been shut off to pay a sum for having the water turned on again is unreasonable(46.)

Under the power to prescribe rules and regulations, it has been held that the installation of water meters may be required, and it is no objection that the entire system is not metered at once.(47)

The practice in relation to shutting off water for non-payment of bills, or abuse of the regulations such as wastage, is governed by the rules which the utility establishes itself under its common law right so to do, and if reasonable and not in conflict with the laws of the state, they are usually upheld by the courts. There is a limitation, however, to this power to shut off water, for non-payment of water rates. It cannot be exercised to compel the payment of a bill which is in dispute. The court will not permit a utility to deny service when the amount due is honestly disputed. When there is no dispute as to the amount due, the right to shut off the water is universally con-

ceded when such action is duly set forth in the rules and regulations. A customer is entitled to a court decision, however, on a disputed bill, but immediately such decision is made the power may be exercised.(48) Of course if a customer's claim is obviously unfair, it will not be considered by the court. Note also that a patron who has a counter claim of doubtful character cannot refuse to make payment for service by setting his claim against current bills.

The importance of setting forth in detail in the rules and regulations the purpose of shutting off water for non-payment is well illustrated by a recent case, where the water service was discontinued for non-payment of a current bill although the customer had a deposit to his credit exceeding the amount of the bill. As the deposit was taken, under a published regulation that all deposits serve as security for any balance due on termination of service, the court held that the utility could deny service if the current bills were not paid when due, as the deposit was not made to be drawn upon for such bills unless so agreed upon.

Denial of service seems to be the most efficient means of combatting improper practices. Rules providing for service denial because of non-payment, diversion of current, and other similar offenses, are upheld. A water utility may shut off water for consumers who habitually furnish water to others.(49) Discontinuance for non-payment cannot be based upon a bill discharged by bankruptcy.(50)

In Maine, the court states that where an old bill has been passed over and later installments accepted, the company cannot make the arrearages the basis for a refusal to continue service.(51)

These are only a few examples of the various sources of laws governing our industry. Time and space do not permit of further discussion. The matter of rates and schedules therefor would alone require a volume, as even the Supreme Court of the United States has not been consistent in its decisions.

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CHANGING TRENDS AND THEIR EFFECT ON WATER UTILITIES

BY ARTHUR E. GORMAN*

[*Read September 21, 1944.*]

MANY Americans are now inclined to speculate with optimism about the effect of X-Day on their future work and responsibilities. This is fully understandable, for we all look forward to the end of this long war and a return to peace; and we all have problems to face in the great transition period ahead. But our first obligation is to see this war to a successful conclusion; and to this end water utility operators have real responsibilities.

I shall discuss these responsibilities from the viewpoint of the War Production Board, and also the effect of changing trends in the outlook of the war as they may affect utilities generally, and New England water utilities in particular.

Utilities render a basic service to communities both in times of war and peace, and therefore their problems and responsibilities are continuing ones. Stability of utility operations must be assured to maintain our national economy. It is only right that they should be fully informed of national programs that may affect their war and post-war operations.

It is the responsibility of the Office of War Utilities to assist all utilities in maintaining their war loads. When the time comes that its jurisdiction and responsibilities are ended, OWU would like to see these utilities in a firm position to meet whatever postwar problems they may have to face. It appears to us that there are two considerations that merit immediate attention by utility operators: (1) maintenance of plant and, (2) early filing of priority applications necessary for materials and equipment to meet existing supply deficiencies.

The Office of War Utilities has already taken actions which should permit a large percentage of utilities to obtain the materials and equipment that will be necessary to solve these problems with

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no further formal priority assistance from Washington. The U-1 Order, which was amended August 31, 1944, and recently circulated to all utilities, makes it no longer necessary to file WPB-2774 applications for minor plant extensions (except certain extensions to serve new consumers), if the net dollar value for materials is $10,000 or less. Previously, this net value was $1,500. The effect of this order will be to reduce the number of WPB-2774 applications processed by the Water Division to one-third the previous load.

Under this amended order the high MRO preference rating of AA-1 may be used for all classes of materials except those for transmission and distribution and for meters. Materials in these classes can, in most instances, be obtained readily with the assigned rating of AA-3. In case of repair of an actual or imminent breakdown, the high AA-1 rating may also be used for these classes of materials. This amended order puts utilities in an excellent position between now and X-Day to initiate actions to correct deficiencies that may now exist because of previous materials limitations. Operators are advised to delay no longer work which is essential for adequate plant maintenance or construction needed to put their systems in a firm position to meet existing war loads or anticipated consumer demands in 1945.

In those cases where WPB clearances are necessary, the Water Division is most anxious to assist. As to long-term construction programs, the sooner policy decisions are made and plans and specifications prepared, the better will be the position of the utility to take advantage of opportunities to obtain materials and manpower after X-Day when controls now in effect will be relaxed. Where such projects involve equipment of long cycle manufacture, it would be prudent to file priority applications before the X-Day controls are relaxed in order that this equipment may be scheduled, if necessary. It is likely that when existing controls are relaxed or revoked rated orders will hold a firmer position as to production than unrated orders.

Relaxations of WPB orders and controls are likely to take place promptly after X-Day. It is quite obvious that there will be a continuing system of controls that will assure production for war purposes. This will probably be in the form of a high priority rating band. Some provision will be made to assure utilities and other essen-

tial civilian services material and equipment necessary to meet operating emergencies. But utilities should be realistic about the effect of relaxations and appreciate the fact that the very favorable position they have held under WPB war controls compared with a fluid economic system probably will not continue. They must be prepared to compete with others for materials and manpower that are available under the post X-Day and post-war economic situation. For these reasons, water utilities with problems involving equipment should have plans ready for their maintenance, rehabilitation, and expansion programs and be alert to their current opportunities as well as their continuing responsibilities. By all means, they should file applications early for projects needed to firm supply in 1945.

As has been publicly announced, WPB's Controlled Materials Plan under which aluminum, steel, and copper have been allocated will probably not continue over 90 days after X-Day. In the case of especially tight construction items such as lumber, it is probable that controls will be continued so long as supply is short of demands for war needs.

With few limitations, the outlook for materials needed for water works maintenance and construction is good. Reinforcing steel is readily available. Reinforced concrete structures involving forms should be planned, however, to use a minimum of form lumber. Many structures of this kind are now being built using existing steel forms. Steel in plate sheet and structural shapes is currently tight but may yet be available in 1944 if impending cut-backs in war orders materialize. This material will be more available in the first quarter in 1945, and from present indications, should be reasonably free in subsequent quarters. The Water Division has obtained a special allocation of steel for elevated tanks for water utilities to assist in meeting a large backlog of deferred construction of this type. Utilities in urgent need of these tanks to improve service and fire protection should file their 2774 applications without delay.

Copper although well stocked for war purposes is still a tight civilian item. It probably will continue so until X-Day relaxations go into effect. Water utilities with limited supplies of copper tubing are anxious that present restrictions be released on tubing in ware-

house, and the Water Division is hopeful of other favorable action in this case in the near future.

As a result of the July 15 amendment to Schedule I of Order L-154, water utilities are now able to purchase the all-bronze body meters. To date, although orders are increasing considerably, the demand for these meters has not exceeded the allocation of secondary metal which has been made for their manufacture. Utilities are requested to coöperate with the meter manufacturer in keeping their orders within the limits of supply until such time as current material restrictions can be removed.

Returning to a consideration of the recently amended U-1 Order, I should like to urge every utility operator to study this order and the administrative letter which Mr. Falck, Director of Office of War Utilities, sent to him under date of August 31, 1944. In addition to the increase from $1,500 to $10,000 in the net value of materials which may be obtained for minor plant extensions, previously referred to, the following are some of the principal features of this order of special current interest:

1. The use of preference rating AA-1 to purchase meters is now limited to cases where they are needed to replace defective meters in service or to replenish the minimum inventory of meters required to be held by a utility for meter replacements. The preference rating of AA-3 must be used when meters are required for other purposes, such as for new customer installations.

2. Restrictions on scheduled deliveries on any quarterly quota basis have been revoked.

3. Utilities whose inventory is $25,000 or less need not maintain their inventory accounts by materials "classes." Purchase of materials by these utilities are to be treated as short items and should not be ordered in excess of a 90 days' supply.

4. Utilities altering or constructing buildings where labor and materials cost exceed $800 must now comply with the provisions of Appendix I, of Schedule A to CMP Regulation 6. If they wish to use materials prohibited by this regulation or if the materials cost is in excess of $10,000, they should apply to the Water Division on WPB Form 2774.

5. With the exception of copper and brass pipe, short order

items may now be ordered in minimum carload quantities or in minimum procurable commercial quantities, even though the amount so obtained is in excess of a 90 days' supply.

6. The Housing Utilities Standards have been still further liberalized to permit extensions of water facilities to 250 feet per dwelling unit for single family detached structures and 200 feet per dwelling unit for multiple family structures. An extension up to 1,000 feet is permitted where required for construction or remodeling of one to three structures. Extension for Victory Gardens have been increased to 1,000 feet of pipe per extension. In all of the above cases, there is no limit in the size of pipe.

7. Clearance of orders through Regional Utility Engineers has been revoked.

Water Utility Inventories. New England utilities have cooperated splendidly in holding their inventories to a minimum. Twenty-seven water utilities have been reporting regularly under Utilities Order U-1. In the following table is summarized some interesting information obtained from these reports:

INVENTORY OF 27 NEW ENGLAND WATER UTILITIES 1942-3-4

Item	*With No WPB Orders 1940*	*Under P-46 as of 12/31/40 March 31, 1942*	*Under P-46 as of 10/10/42 March 31, 1943*	*Under U-1 as of 3/31/44 March 31, 1944*
Number of Consumers	596,000	609,000	614,000	615,000
Av. Water Output-mgd	270	304	317	320
P-46 or U-1 Inventory Base	none	$1,570,000	$988,000	$1,152,000
Practical Working Minimum Inventory	—	—	$1,121,000	$1,055,000
Excess Inventory	—	—	$389,000	$357,000
Total Inventory	$1,570,000	$1,719,000	$1,505,000	$1,412,000

The practical working minimum inventory reported for March 31, 1944, showed a decrease of 33 per cent under the total reported inventory of December 31, 1940. As of March 31, 1944, the practical minimum inventory of these water utilities was 92 per cent of the

allowable U-1 base. Their reported excess inventory was about $357,000, over 95 per cent of which was in the transmission and distribution class. It is interesting to note that although the number of their consumers increased but 3.1 per cent for the period December 31, 1940, through March 31, 1944, the increase in water output was 18 per cent for the same period.

War Impact on Water Utilities. New England water utilities have met the impact of war conditions remarkably well. This is due in part to firmer supply conditions and perhaps to the more conservative standards that were followed in sizing of distribution and transmission mains. With relatively few water treatment plants in New England, restriction in plant output for public health reasons did not create serious problems. As a result, your utilities had greater elasticity in meeting peak demands.

On a national percentage basis, New England's war industrial rating score was about in line with its population rating. However, its war industries were not those which required abnormally large volumes of water such as are needed for the production of gasoline, alcohol, and various kindred products. Therefore, utility systems in this area did not have to face the serious hazards of overdraft of safe yields of their sources of supply to the extent experienced by other utilities, particularly those in the Central and Southwest Areas and on the Pacific Coast. New England utilities did have to meet a serious war housing load which called for extensions of distribution systems and some additional supply facilities, especially those utilities whose normal supplies were from wells. Relatively, construction of army camps, naval bases, and air fields in New England was not as great as in the South and Southwest; and therefore the overload of existing systems to meet this type of demand was not as serious as in these sections of the country.

Current Water Utility Construction. It is of interest to note the current trend of water utility applications for construction projects in New England as compared with that in the entire United States. In proportion to population, both the number and project costs in New England have been low. This is shown in the following table:

WPB-2774 PROJECT APPLICATIONS RECEIVED MARCH-MAY, INCL., 1944

	United States	*New England*	*Percent N.E. of U.S.*
Urban Population 1940	74,400,000	6,400,000	8.6
No. WPB-2774 Applications Received by Water Division	1,157	41	3.5
Total Materials Cost	$21,700,000	$320,000	1.5
Total Project Cost	$39,300,000	$581,000	1.5
War Industrial Rating Score	2060	168	8.1

The New England water utility projects are mostly for supply, transmission, and distribution facilities and differ from the national picture quite markedly as to treatment and distribution projects as shown below:

COMPARISON OF WATER UTILITY PROJECTS BY TYPE OF CONSTRUCTION

	Per cent of 1944 Projects	
	United States	*New England*
Supply	41	48
Treatment	32	2
Pumping	8	5
Transmission and Distribution	19	45
Total	100	100

Rainfall. In general, the nation has been fortunate in experiencing no long sustained deficiencies in rainfall during the war period. Had they occurred, the problems of water supply to meet the demands of war production would have multiplied many times. It is too much to expect that this favorable situation will continue to hold. This is one of the principal reasons the Office of War Utilities is anxious that water utilities, which have deferred construction needed to firm supply, start work in the near future on their normal programs. Fortunately, because of favorable rain and snowfall, several water utility systems that have had demands in excess of safe yields were able to meet war loads. For large cities, it may take one or more years to complete construction of deferred supply facilities. Now that materials are more available, it would be prudent for them to start con-

struction, because if precipitation becomes subnormal for a year they may be faced with a serious water shortage.

To September 1 of this year the cumulative rainfall in New England has been subnormal in each state. The deficiencies were especially high in Rhode Island, Maine, and Connecticut, where they were 29.7, 22.5, and 21.0 per cent, respectively, below normal. The hurricane rainfalls brought some improvement to Rhode Island and Connecticut. No reports of serious interruption of water service have been received as a result of this storm, although power failures of short duration did occur.

Some New England water systems are likely to be seriously embarrassed if subnormal rainfall conditions continue in the last quarter of this year. Several are now faced with deficiencies as to supply and transmission that should be remedied at the earliest possible date. The Water Division will be pleased to help them to obtain the necessary material and manpower.

Manpower. The manpower situation continues to be serious over wide sections of the nation. In New England, the Hartford, New Haven, and Bridgeport areas are especially tight. For many months the War Production Board has required that construction projects in thirteen areas be cleared by Area Urgency Committees at regional and district offices as to availability of manpower before final approval of priority applications. Since August 1, 1944, it has been necessary that manpower clearances be obtained from similar committees—whose jurisdiction extends over a large part of the nation—for all utility projects requiring more than 25 additional employees.

The manpower shortage has also handicapped utilities in their normal maintenance and repair work. The cumulative effect of this situation could become serious, and utility operators should be alert to this possibility. It is doubtful if ever before there has been greater need of ingenuity in maintaining utility plants than at this time. With the cutbacks in military demands that will follow X-Day, manpower should become more available, but apparently until our soldiers begin to return in substantial numbers manpower problems must be reckoned with.

Fuel For Utilities. Estimates of available supply and potential demand for coal this winter indicate that there may be some shortages

of this fuel. Because of possible transportation difficulties due to heavy snow storms, water utilities in New England would do well to place orders for coal at an early date. Stockpiling of coal permitted utilities varies considerably, depending on supply conditions, but in general, New England utilities are allowed to hold 40 day's supply in reserve.

Should any utility operator have difficulty in obtaining coal from his normal source and be threatened with a shortage of supply, the Water Division should be notified. Coal deliveries to meet requirements will be arranged for, but under these conditions it may not always be possible to obtain coal of the grade normally used. Seasonal reconditioning of coal burning equipment in order to prepare against this contingency is recommended.

Construction After X-Day. The favorable prospect that materials and manpower will be increasingly available after the war with Germany is terminated makes it all the more important that water utilities have plans ready in order that they may start construction on improvements to their systems on both short-term and long-term programs.

Some utilities still have real deficiencies in their systems that should be relieved. Others, as a result of war expansions, will be in a firm position as to supply and service for many years to come. Almost all operators are concerned over the effect of deferred maintenance on their plant and equipment. Based on its experience with water utilities, the Water Division is confident that they will meet the problems of conversion from a wartime to a peacetime economy with the same courage and confidence with which they supported the nation's war effort.

The outstanding record of water utilities throughout the nation in meeting war loads, often under most trying circumstances as to availability of materials and manpower, is one of which all in the industry can be proud. The cooperation that the Water Division and the Office of War Utilities have received from operators of water systems and producers of water works supplies and equipment has been genuine and effective and is deeply appreciated.

Some day I hope the story of the important contribution that water utilities made in supporting war production during the last

three years will be properly recorded so that the public may have a basis for full appreciation of the service that was rendered them.

Summary. I would summarize the points covered in this paper as follows:

1. Water utilities have a continuing responsibility to serve their communities in war or peace and are urged to maintain plant and correct deficiencies that may exist.

2. The amended U-1 Order of August 31, 1944, relaxes controls and restrictions on materials needed for utility maintenance, repairs, and operation and permits minor plant extensions without special priority approval provided that net materials costs do not exceed $10,000.

3. Promptly after X-Day when Germany surrenders, the War Production Board will relax markedly its controls over most materials in demand to meet needs of our civilian economy. The Controlled Materials Plan will probably be terminated within 90 days after X-Day. A high priority band will assure materials for war production and probably for urgent civilian needs.

4. After X-Day rated orders in effect at that time are likely to have a preferential position over subsequent unrated orders as to production. Therefore, utilities should file applications promptly for priority ratings on any construction project essential to meet existing deficiencies or to firm supply in 1945. This is especially true for equipment having a long cycle of manufacture.

5. With the exception of lumber, most materials needed for water works construction are now available or will be in the fourth quarter of 1944 or the first quarter of 1945.

6. The manpower situation continues to be tight. Over large areas of the country, special WPB committees must first approve the use of manpower on construction projects before priority ratings can be issued. These restrictions may be relaxed after X-day.

7. To September 1, rainfall in New England for 1944 was subnormal with serious deficiencies in Rhode Island, Maine, and Connecticut; and many water utilities are faced with the problem of curtailment of consumption.

8. There are indications that coal may be in short supply this winter. Water utilities would be prudent to order their coal early.

Should any experience difficulties in obtaining coal, if they will notify the Water Division, steps will be taken promptly to assist them.

9. The problems of maintaining water supply during the war revealed some weaknesses in water utility systems and policies, corrections of which might well be considered in post-war planning.

Both "Cap" Krug, who, as you know, is now Acting Chairman of the War Production Board, and Ed Falck, who succeeded him as Director of the Office of War Utilities wish me to thank the officers and members of the New England Water Works Association for the excellent coöperation given to OWU in discharging its responsibilities of assuring adequate utility service for war production. Your members have served on committees with representatives of the American Water Works Association, the Maine Utilities Association, and others and have given freely of their time and abilities in advising the Water Division in matters of policy affecting water utilities. These committee meetings were important to the Water Division in formulating programs and policies, and they brought us closer to the utility operators whom we wished to serve. I should like especially to acknowledge the fine service which Horace Cook and Sam Ellsworth of this Association gave as members of their committees.

In closing, I wish personally to thank your Program Committee for the invitation to meet with you at this convention; and I should like also to extend to this Association the sincere appreciation and thanks of the entire staff of the Water Division, the members of which came largely from the ranks of water utilities.

ANNUITIES FOR PUBLIC SERVICE EMPLOYEES

BY F. J. RENY*

[*Read September 22, 1944.*]

A short discussion of annuities or pensions for public service employees would seem to necessitate a few general remarks in connection with the social, economic, and historical background. Experience in public service, although it might not be in a technical or legal capacity, is essential in order to properly describe the status of such employees.

There has always been a tradition in other branches of American industries in regard to taking care of employees in their old age. Usually the aged employee was given a pension when he was no longer able to work. By a pension we mean, according to Webster's definition, "A payment legally made to any person as by way of subsidy, gratuity, etc., or a stated allowance to one retired from service."

Pensions given to employees who became too old to work or disabled have been customary for many years. The pension in some cases has been as much as fifty per cent of the salary. In the majority of industries the employee had not been requested during his term of service to contribute to a pension fund; consequently, the gift of a pension by his employer had to be charged to operating expense. As long as the business was able to stand the additional expense, the employee was well cared for, but it soon became apparent that when "hard times came knocking at the door," and profits grew less, the pension was liable to be cut or done away with altogether.

The practice of giving free pensions to employees in private industries has, to a certain extent, been changed for the reason that the personal and intimate relationship between the employer and employee has been changed. Many of us can remember when the employees of a large factory were like a large family and the employers the parents of the family. Personal loans to employees to

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build homes, presents at Thanksgiving and Christmas, were the usual thing in the factories in the little city where I was born. For many years this custom prevailed. Later on, as business conditions changed, it became necessary to be more strict and businesslike in dealing with employees, and a great deal of the personal touch between employer and employee was lost. These changes, in most cases, were due to different social and economic plans proposed for the benefit of employees. Possibly the average American working man may prefer these plans rather than the paternalistic system of other days. Regardless of their desires, it was soon to be settled for them.

Social Security. We all remember very clearly what our reactions were to the first acts of the present administration in the White House. Forcibly and financially most of us found the New Deal, closing of the banks, impounding millions of the depositors' money, a strange remedy for financial ills, which are still ailing. Even after twelve years, the effect has not eradicated the cause. However, in August, 1935, came the Social Security Act, passed by Congress and upheld by the Supreme Court of the U. S. in 1937. Amendments followed in 1939. The Act provides two insurance programs. The first of these is "An old age and survivors insurance designed to furnish the worker and his family something to live on when he is too old to work and to assure an income to his dependents after his death."

This system is administered by the Federal Government. The cost of paying Federal old-age pensions is met by taxes which are levied in equal amounts on both employer and employee, based on wages for covered employment. The provisions which levy these taxes are incorporated in the Federal Insurance Contribution Act. This tax applies to employers of one or more workers and to their employees.

Section 2 of the Social Security Act covers the Co-operative State-Federal Unemployment Insurance. We are not interested in this section.

Most of us are very much interested in a plan of real Social Security in which all might be included. It cannot be considered a perfect law which gives security for some of the employed personnel throughout the nation but which purposely excludes all others. Public service employees are excluded from the Social Security Act under

exceptions, Section F, "Service performed in the employ of Federal, State, or local governments and certain of their instrumentalities."

Inasmuch as we are public service employees and were, for a time, exempt from Federal income taxes, it was evidently considered to be righteous that we be excluded from this Act. Possibly we might be permitted to be included by request, but in the State of Maine, where we meet as a water works association and have discussed the situation, it is believed that Social Security is not available to us as public service employees. This includes not only public service employees of a public water company or district, but also all employees of a municipality such as the street departments, park departments, city hall, and others. Evidently they believe the municipalities should bear the burden of caring for their own old-timers.

Laws on the statute books in Maine provide that pensions of fifty per cent of salary shall be paid to policemen and firemen in Portland after twenty-five years of service. No contribution is made by them to this pension. On the other hand, teachers are obliged to contribute to a pension plan.

Up to 1933, it was not legal to set aside a reserve for the pensioning of municipal employees, but an act was put through that year legalizing this. Later in 1941, Chapter 329 of the Public Laws of Maine, Section One, P. L. 1933, 227C, Paragraph 3, Amended Laws of 1933, it became legal to join a contributory retirement plan for state employees, except teachers. This act provided that state employees could contribute to a plan to retire at age 65 or 70, and any person who became a member prior to July 1, 1943, and who had a total prior service record of at least twenty-two years shall be entitled to a retirement allowance of one-half average compensation, provided that he is still a member and has a creditable service of at least twenty-five years on retirement. Also, any employee, if he elects, could pay into the retirement plan any or all back contributions to July 1, 1943, and receive therefor the proper credit for which such back contributions are made.

Under this act, municipal employees of a city or town in Maine may become members of a contributory pension plan.

Portland Water District Policy. As a public municipal corporation, the policy adopted by the Portland Water District in regard to

the employee's interest and welfare is interesting, and I believe it reflects the broad, generous attitude consistent with the trustees of this utility.

In 1927, a plan of group insurance was put into effect without cost to the employee. Under this group policy, any regular employee was insured for the sum of $1,000, increasing $100 each year until the principal sum of $2,000 was reached at the end of ten years' service. The total premium of this group policy has been about $1,900 per year for about sixty employees. I know how valuable this insurance is as I have personally delivered a check for $2,000 to the beneficiaries of some of our men who have passed away. In some cases this was all the insurance they had.

In 1932, several of our men had reached the age of retirement, and as we had no pension plan and it was illegal at that time to set aside a reserve for pensions by municipalities, the simple way seemed to be to pay a certain sum each week to the aged men. Two of these men had rendered especially valuable service to the water works, having spent all their lives in this work. Consequently, a generous allowance was made to these two men. This proved to be a dangerous precedent. One man lived to a very advanced age and more than $13,000 was paid to him as a pension over a period of thirteen years.

Group Annuity. Late in 1932, we began to investigate the cost of group annuities for our employees. Accordingly, information was requested from three of the largest insurance companies in the world which were at that time selling group annuities. No pre-arranged plan had been thought of by the officials of the District, but the questions to be answered were plainly in our minds, and they were roughly as follows:

The insurance companies were requested to provide us with a plan whereby the total cost of past service for our group might be paid as a single premium which would insure our whole group of employees for past service only. They were also asked to estimate the probable cost per year for future service for these employees to retire at age 65 on the basis of one per cent of salary multiplied by years of service. Finally they were asked for recommendations regarding a group annuity plan with or without contribution from employees.

In response to our requests, three of the insurance companies submitted plans that had been prepared by their actuaries for a group annuity plan for the Portland Water District. Upon examination of each plan, it was found that it was possible to insure the entire group for past service only and that the cost of the single premium to be paid in advance was in each case approximately $100,000. In addition to this, there were three employees who already exceeded age 65, and the cost for these was about $5,000. The rate of interest to be paid by the insurance company at that time was three per cent.

The question of future service for the group was in one case guaranteed to be approximately $5,000 per year for a period of three years, and in the other two cases about the same, with no guarantee for more than a single year. The division of the cost of the annuity was left to us as to the contribution by employer and employee.

This was roughly the plan submitted by the insurance companies for group annuities for our group, and the plan was submitted to the Trustees of the District and discussion was had at various meetings in regard to this extraordinary expense. As you may imagine, the Trustees regarded the payment of more than $100,000 for past service as excessive for the reason that the Water District, as a public utility, is owned by the Cities of Portland and South Portland.

At that time, there was no opportunity for those municipalities to secure annuities for their employees, as the cost would have been tremendous and both cities were already groaning under excess taxation, as they are at the present time. Consequently, it was necessary and correct to refuse to adopt this plan for the reason that the employees of the Water District could not expect to be given an annuity when the city employees were just as deserving of the same privilege. Therefore, this plan was discarded.

Other plans were submitted at the same time by other companies for a pension trust. After consideration, however, the plan of pension trust did not appeal to us for the reason that we felt that it was difficult to handle and we desired simplicity above everything else in the plan that we would adopt, and the complications of the pension trust plan were discarded as not essential to our needs.

After many discussions, we presented to the Trustees a plan that we had designed ourselves which we believed would be successful

and simple in its operation and also give each employee the same amount of protection that he would be receiving if he could have Social Security. Under this plan, we carry our own annuity for our employees in the following fashion:

The authority for the pension or retirement plan was vested in the Trustees of the Portland Water District. The purpose of the plan was to retire each regular employee who had attained the age of 65 or more and to provide a percentage of his income multiplied by the years of service in order to give him the benefit of past service. All employees of the District were included, male and female, and reserves were set aside each year in the amount of $6,000, defined as the Portland Water District Annuity Fund Reserve. This pension fund was, of course, a book reserve, and all funds paid to annuitants were charged to this reserve. Any employee who became 65 years of age, or perhaps became disabled, was considered in the plan. A minimum was established on the basis of Social Security so that when an employee, regardless of his length of service, became 65 he could be retired by vote of the Board of Trustees on a minimum of $1.00 per day, or $30.00 per month. The plan was set up on the basis that all of the expense of the annuity would be borne by the employer, and thus far it has not been necessary to solicit any contribution from any member of the plan.

In addition to the plan of minimums at $30.00 per month, any employee who had previous past service could be retired on the basis of one per cent of his salary multiplied by his years of service. Thus, an employee of twenty-five years' service who received a salary of $40.00 per week would receive one per cent of his weekly salary multiplied by twenty-five years, or $10.00 per week as an annuity.

In addition to this it was decided that an employee who became disabled or was retired before age 65 because of disability or other reasons should be given the percentage of his years of service in proportion to what it would have been if he had stayed at work until 65.

Further examination of this plan brought out the fact that employees are rarely ready for retirement. Human nature seems to be so constituted that when a man's salary is raised, for some unknown reason, expenses and spending also increase at the same time, and when the time comes to retire usually the employee does not have

reserves to take care of outstanding bills. Having noted this fact, we further simplified the annuity plan by giving the employee the added advantage of having his full pay paid to him for as many weeks as he had served years.

During the ten years that we have operated on this plan we have still been working on the idea of finding some way to fund an irrevocable reserve to take care of our annuitants. At the present time, the Portland Water District has accumulated during a period of ten years $100,000 in U. S. Government bonds bearing interest at two and one-half per cent, and these have been added to the Annuity Fund Reserve. As time goes on we hope that the reserve may still be built to the point where the income from the fund will be enough to take care of the amount spent for our annuitants.

Our experience in ten years has seemingly borne out the fact that public service employees as a whole, in our utility at least, make no preparation for retirement, and as I have stated, they do not as a rule continue on the list to the end of expectancy. At the present time we have eight employees on our annuity list and the cost per week for these annuitants is $68.59. The amounts paid are $7.00 to $16.00 per week.

It is confidently expected that with improvement in revenue and lessening of operating expense opportunity to enlarge our reserves for annuity may come each year. You will note by this plan that the Portland Water District at least realizes the fact that the expense of taking care of the old-timers is recognized as a logical expense to be assumed by the utility.

If we have been under-generous in our minimums or over-generous in our method of dealing with employees who do not save, perhaps we should be criticized. At least we have relieved ourselves of the burden of having any of our employees who may reach retirement age provide embarrassment to the Water District because no plan has been made for them in their old age after they have rendered a lifetime of service to the utility. It remains for each public utility to find a method of funding a reserve for retiring their employees so that there will not be embarrassment for the utility and others may not be asked to assume a just and correct burden for these employees who seemingly have been overlooked in the governmental shuffle.

FALL RIVER INDUSTRIAL WATER SUPPLY

BY JOHN L. HAYDEN*

[*Read September 21, 1944*]

THE Advent of World War II brought many problems to the municipalities of this country, particularly through the pressure of suddenly expanded production facilities. These problems involved many of the municipal functions, not the least of which was water supply. The demands for more water, as a result of a sharp rise in population and a greater use of water for industrial processes, required the immediate expansion of many of the water works systems.

In the early stages of the war, the Federal Government recognized the need for expanding these and other public utilities and made provisions to aid in such improvements. It, therefore, became one of the functions of the Federal Works Agency to provide financial assistance to cities and towns for construction of additions or alterations to the existing water supply systems where such systems were found to be inadequate because of unplanned and unexpected increases in industrial production due entirely to the war.

Since New England has always been an industrial center, the impact of industrial expansion was felt here as well as in other areas of the country. The city of Fall River, Mass., was one of these New England municipalities where the sudden expansion of industrial facilities with the attendant increased demand for both domestic and industrial water supply created a serious shortage.

Fall River is located in the southern part of Massachusetts near the eastern boundary of Rhode Island, and its western boundary is the mouth of the Taunton River and Mt. Hope Bay. The city has an area of 41 square miles and a normal population of 115,000. It is the center of military and naval activities which include Camp Miles Standish on the north with fifteen to twenty thousand men, Camp Edwards to the east with thirty-five to forty thousand men, several smaller army installations along the shore, and the Newport

*Hayden, Harding, & Buchanan, Boston, Mass.

Naval Training and Torpedo Stations to the south with thousands more men.

These military and naval installations and the tremendous increase in manufacturing activities within the city have been the prime reasons for a population increase far above any normal anticipated growth and have taxed the municipal services beyond their designed capacity.

Shortly after the sneak attack on Pearl Harbor, December 7, 1941, every square foot of manufacturing space was occupied by new and established firms for the production of war materials. This was naturally attended by an immediate demand for process water. The result was that industrial water consumption was increased to a point where it was necessary to supplement this supply with water from the already overburdened domestic source of supply.

For many years previous to the war, Fall River's foresighted city officials, Mayor Alexander C. Murray and Water Superintendent John W. Moran, had anticipated such an industrial expansion with a resultant population increase, but expected that it would occur over a longer period of years. As a result of this long-range planning, prompted by definite indications of industrial growth, numerous studies and surveys were made in the Fall River area with the hope of securing an auxiliary water supply as it was needed.

The first watershed considered was Long Pond, located in Lakeville, approximately nine miles from Fall River. The yield of this pond is already used by other water supplies and could easily supply adequate water for Fall River. The second watershed, Bread and Cheese Brook, is located in Westport. Although only a short distance from both the domestic and industrial ponds, it could not yield sufficient water to act as an auxiliary water supply. As a result of these studies, it was found that although Long Pond had a sufficient supply of water available, the cost of acquiring lands, water rights, and construction was discouraging. Therefore, plans for an auxiliary water supply were temporarily laid aside.

When the impact of industrial expansion hit the city after Pearl Harbor, it became apparent that the resumption of studies for additional water supply was imperative if the plants were to have sufficient water for continuous operation. At this point Hayden, Harding

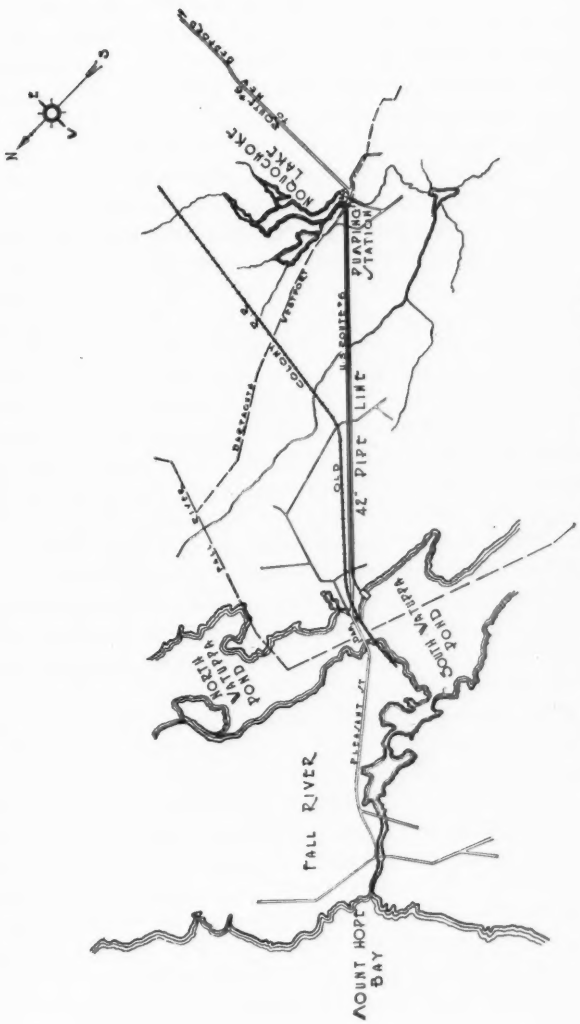

FIG. 1.—INDUSTRIAL WATER SUPPLY, FALL RIVER, MASS.

& Buchanan were retained to make further investigations in an attempt to locate a supply of water at the lowest possible cost to the city to supply the needs of the industries and at the same time to conserve the domestic supply. To understand this statement, it is necessary to explain the method of operation of the domestic and industrial water supply systems in Fall River. See Figure 1.

North Watuppa Pond, the domestic supply, has a watershed area of 9.14 square miles and an average safe yield of 7 m.g.d. The average demand for the year 1940, or previous to the war, was 6.75 m.g.d. South Watuppa Pond has a watershed area of 18.14 square miles with an average yield of 15 m.g.d. The average demand by the manufacturing plants previous to the war was approximately 15 m.g.d. or the same as the yield. These two ponds are separated by a dam and Federal Highway No. 6 and have a set of manually operated gates which control the relative levels of the two ponds. The gate arrangement is such that it is possible to flow water from North Watuppa Pond to South Watuppa Pond only. Consequently, any excessive draft on South Watuppa Pond for industrial process water meant that the gates would be opened to allow water from North Watuppa Pond to flow out with the resultant effect of taxing the already overburdened domestic supply beyond safety.

The solution to this problem has become such an important part in the operation of these two ponds that a brief description is needed to give a clear picture of the different phases of operation that will be discussed later in this paper.

The pumping station constructed on the shore of Lake Noquochoke in Westport pumps water through a 42-inch transmission line, 4.2 miles in length, to an outlet constructed on the east shore of South Watuppa Pond. The water pumped from Lake Noquochoke, combined with the yield from South Watuppa Pond, is then discharged through a controlled dam on the west shore of South Watuppa Pond into the Quequechan river. This river flows in a north-westerly direction through the heart of Fall River and thence into Mount Hope Bay. All along the banks of this river are located the plants vitally affected by the shortage of water for war production. These plants are now taking water from the Quequechan River by means of ponded areas created by dams along the course of the river.

The first step towards determining the amount of process water needed was a survey of all the plants new and old that were using South Watuppa Pond as their source of supply. The result of a survey of forty of these plants, all the facilities of which were 100 per cent in production of war materials, was that in 1940 their use of process water was 15 m.g.d. and that in less than a year this would be increased to a total of 31 m.g.d.

It was easy to see that such a heavy draft on South Watuppa Pond could not continue without disastrous results to the domestic supply. In Table 1 are shown the area, yield, and consumption demands for these two ponds.

TABLE 1.—AREA YIELD AND CONSUMPTION DEMANDS FOR NORTH AND SOUTH WATUPPA PONDS.

Pond	Sq. miles	Yield—Gallons per day Minimum	Average	Normal demand
North Watuppa	9.14	(minus) 2,300,000	7,000,000	6,745,000
South Watuppa	18.14	(minus) 4,921,000	15,000,000	15,000,000

To further aggravate the situation, it was anticipated when the study was made that exceedingly dry seasons were at hand. This proved to be truer than expected. In 1943, only 31.43 inches of rainfall was recorded in the Fall River area, against a normal annual rainfall of 45.12 inches.

It was concluded therefore that: (1) Any heavy draft on South Watuppa Pond would mean a shut-down of war industries or endanger the domestic supply by operating the gate between the two ponds; (2) the normal amount of rainfall and run-off had not been impounded; and (3) with the knowledge that during dry months there is a minus yield of almost 5 m.g.d in South Watuppa Pond, an auxiliary supply must be found which would be capable of producing 20 m.g.d. when needed.

Source of Water. While the survey of the plants was carried on, consideration was being given to Lake Noquochoke as a potential source of additional water. This lake is located on the Westport-Dartmouth town lines, 4.2 miles from the Fall River-Westport line, and has a watershed area of 28.7 square miles.

A series of flow tests, run-off, and yield studies was made, and the result clearly indicated that unlike North and South Watuppa Ponds, Lake Noquochoke never yielded a minus quantity of water and its average yield was 25 m.g.d. Comparative figures for the three (3) watersheds are shown in Table 2.

TABLE 2.—YIELDS OF NORTH AND SOUTH WATUPPA PONDS AND LAKE NOQUOCHOKE.

Ponds	Sq. miles	Yield G.P.D. Minimum	Yield G.P.D. Average	Yield G.P.D. Duration of war
North Watuppa	9.14	(minus) 2,300,000	7,000,000	8,000,000
South Watuppa	18.14	(minus) 4,921,000	15,000.000	31,000,000
Noquochoke	28.70	4,498,000	25,000,000	20,000,000

With this information, the selection of Lake Noquochoke for an auxiliary water supply was made, land and water rights quickly acquired, and construction plans started immediately.

Pumping Station. On the property acquired by the city was an old office building connected with an abandoned plant known as Westport Factory. This was located on the west shore of Lake Noquochoke a few feet up stream from a dam that controlled the water level in the lake. This location was ideal for the pumping station, and the office building was razed and its foundation removed.

The pumping station location was approximately a half mile from the nearest point where adequate power was available. Consequently the cost of operating with electric motors would include the expense of extending existing lines. Even in normal times this expense would not have been justified, but in addition, the severe shortage of copper wire needed to string a line eliminated the use of electric motors from consideration. Diesel engines were, therefore, selected on the basis of low operating and maintenance cost.

Flume and Travelling Screen. Water flows to the pumping station through a concrete flume. The flume is 6 ft. wide with wing walls at the edge of the lake and is completely covered for a distance of 25 ft. to the wall of the pumping station by precast concrete planks. To eliminate the debris that normally would enter a flume of this

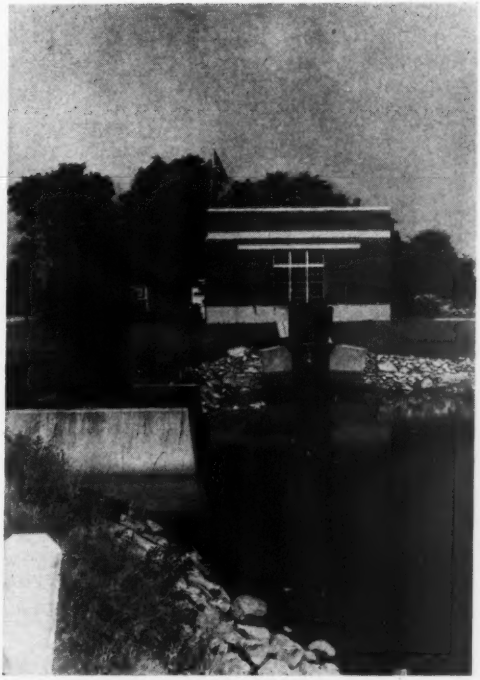

FIG. 2.—PUMPING STATION AND INTAKE ON NOQUOCHOKE.

type, a travelling water screen was installed just back of the wing walls, See Figure 2.

This screen is controlled from the panel in the station and is driven by an electric motor. It has a unit heater controlled by a thermostat and magnetic contactor mounted within the steel housing of the screen. Temperature is maintained at 40° F. when the outside temperature falls to as low as 20° F. below zero.

Foundations. The flume on entering the building is split in the shape of a "Y" to form the intake wells for each of the two centrifugal pumps mounted directly over them. Behind the intake wells are

mass concrete foundations which support the Diesel engines. These Diesel foundations form a common wall at one end of the intake wells and measure 8 ft. in width and 18 ft. in length. The foundation units are 9 ft. deep, extending from the pump room floor to below the basement floor and contain approximately 50 cu. yd. of concrete each.

By utilizing every square foot of area in the chases formed by the Diesel foundations and intake wells, it was possible to locate most of the control piping and equipment in the basement and at the same time to maintain wide walkways and ample room for removal and repair of equipment.

The equipment placed in these areas included: air tanks; automatic station heating plant; two automatic 10.2 c.f.m. air compressors, one driven by a 3 hp. electric motor and the other standby unit by a 3 hp. gasoline engine; a deep well ejector type pump installed over a 2½-in. well under the basement floor, that supplies the station with fresh water for drinking and sanitary purposes; a self-priming sump pump having a capacity of 150 g.p.m. in a sump pit below the basement floor with float controls for stopping and starting the pump; two cone check valves, one on each 18-in. discharge line; two 18-in. discharge lines terminating at a "Y" connection under the foundation wall and leading to the 42-in. pipe line; and miscellaneous control piping strung below the operating floor and painted with various colors to determine its service.

Pumping units. The pumping units consist of two 16-in. bottom suction, single stage, centrifugal pumps. Each pump has a capacity of 6900 g.p.m., operating against a 93-ft. working head with an average suction lift of 10 ft. Each pump is powered by a Fairbanks-Morse 3-cylinder, 225 hp. Diesel engine operating at a rate of 300 r.p.m. and connected to the pump through speed increasor gears of the herring bone type. The gear ratio of approximately one to two increases the rotative speed of the Diesel engines operating at 300 r.p.m. to the pump operating speed of 635 r.p.m

Both Diesels are equipped with a pump to recirculate soft water through the Diesels and heat exchangers. An ample quantity of raw cold water is received from the discharge of the main pumps. Both Diesels are equipped with snubbers on the exhaust system, extending through the roof to muffle the discharge explosions.

Since the centrifugal pumps were located above the water level, a combination manual and automatic system of priming was adopted. This consisted of 36-in. by 72-in. float control tanks and two rotary vacuum pumps located on the pump room floor. One vacuum pump is driven by an electric motor arranged for automatic control by float switches on the tank which maintains a predetermined suction water level above the volute of the centrifugal pumps. Between tank and pumps, float operated valves are placed in pipe connections to insure constant removal of air which might accumulate in the suction line. The second vacuum pump is driven by a small air-cooled gas engine and is manually controlled for emergency use.

Control Panel. The control panel consists of two formed 10-gage steel panels, completely enclosed in a cubicle with removable plates on top, back, and both sides. All gages, instruments, and other equipment are flush mounted, and every operation in the pumping station is controlled from this board.

Building. The pumping station is of semi modernistic design. Treatment of the exterior is dark red water-struck brick over a concrete foundation smoothly finished together with cast stone corners and belt courses that give a pleasing effect. Metal sash is used throughout, which in addition to supplying the maximum amount of light, enhances, rather than detracts from the appearance of the building. The walls, floor, and ceiling are painted in pleasing and harmonious colors with durable masonry paint. The interior walls are of buff glazed tile. An office and toilet are provided in addition to all the other equipment previously mentioned. The building is of fire-resistant construction with tar and gravel roof.

Pipe Line. Throughout the distance of 4.2 miles from the pumping station at Lake Noquochoke to South Watuppa Pond a 20-ft. grass plot separates a four-lane concrete highway. This stretch of highway is straight and offered an ideal location for the pipe. Upon request of Mayor Alexander C. Murray of Fall River, legislative approval was given to lay the pipe in the grass strip. In the selection of the type and size of pipe, conservation of vital war materials was the paramount issue.

The most efficient operation of the two pumps operating as a unit or separately was found to be with a discharge conduit 42-in.

in diameter. Therefore, a 42-inch Lock Joint concrete pipe line was selected. The design of this type of pipe is well known, but there was one variation in its design for this particular job which is interesting. To conserve steel, instead of having a steel cylinder core with wire mesh on either side and concrete grouting all around the frame, the pipe was so designed that the reinforcing was graded, *i.e.*, the higher the pressure, the more reinforcing; conversely as the pipe neared the top of the pumping lift, the reinforcing was reduced. In this manner, it was possible to eliminate the steel cylinder and make a saving of 120 tons of steel. That this design was sound was proven in subsequent field pressure test when no leakage was recorded at 200 per cent working pressure.

Controls. At the pumping station end of the pipe line, an 8-in. blow off has been tapped into the 42-in. pipe with overflow into Lake Noquochoke, controlled by a gate in front of the pumping station. At five high points along the pipe line, automatic air-release valves and chambers are installed. Fire protection is provided to Westport villages by 15 hydrants placed at strategic locations.

The weight and size of this pipe presented many problems in the selection of a method of operations that would insure speed in laying, and at the same time an uninterrupted flow of traffic on the busy highway between Fall River and New Bedford. The method adopted was to string the pipe to be laid along one edge of the grass strip, excavate the rest of the grass strip to an 8-ft. depth, and place the excavated earth on two lanes of the highway. In this way it was possible to maintain two-way traffic on one side of the highway at all times.

The actual laying of the pipe centered around two large back hoes operating as separate units, see Figure 3. Each machine, traveling in reverse, excavated the trench, picked up the pipe with a steel cable sling, lowered it into the trench, and guided the spigot end of the joints into the bell. With this method, it was possible for each machine and crew to lay between eighteen and twenty pipes per day.

The speed of this operation depended on well regulated delivery of 42-in. pipe. With this in mind, the manufacturers located a plant near the project and delivered the pipe by truck immediately after the curing period was completed. Having uninterrupted delivery of

FIG. 3.—LAYING OF 42-IN. LOCK-JOINT CONCRETE PIPE IN CENTER STRIP OF FOUR-LANE HIGHWAY.

the pipe helped materially in attaining a completion date sooner than estimated.

Costs. The total cost of this project was proportionately shared by Fall River and the Federal Government. The city of Fall River contributed $165,000 and the Federal Government $245,000, or a total estimated cost of $410,000. The work was done under two separate contracts, one for the pumping station and the other for the pipe line. The cost of the completed pipe line was $291,490 and that of the completed pumping station $97,003.

The first 835,000,000 gallons were pumped at a cost for labor of $4,470 and for fuel of $1,260, or $6.85 per m.g.

In conclusion it can be said that by the construction of this pipe line and pumping station, Fall River has protected its domestic supply from over consumption; obtained an auxiliary water supply

that may be used in the future, after proper treatment, to augment its domestic water supply; and, last and most important of all, provided the industries now manufacturing war materials with sufficient water to meet their needs for the duration of the war and at a minimum cost to the tax payer.

WATER PURIFICATION PROBLEMS AT DURHAM, N. H.

BY KENNETH E. GUNN*

[*Read May 18, 1944.*]

PROBLEMS in the operation of a water purification plant differ with the type of plant involved; also with the type of water to be treated. This paper will briefly list and explain what was done to solve the problems that are common to rapid sand filters such as those at Durham, N. H.

The run off that reaches the brooks and rivers of a New England water shed is highly polluted from the barnyards of the farms that are scattered over these areas. Samples of water taken from the Durham reservoir during a dry season show a total count of 100 bacteria per ml, while during a wet season, the count is as high as 17,000 per ml. In order to assure bacteria-free drinking water during the rainy seasons, the dosage of chlorine added to the filtered water is, therefore, stepped up.

The small bodies of water that are found on the water shed contain an abundance of decayed vegetation, which, during a heavy rain, overflows, causing this decayed matter to run into the streams supplying the reservoir. Here is the cause for the greatest problems an operator must contend with. These are high color and excessive odors which necessitate increased dosages of alum and activated carbon. The color at Durham goes as high as 130 ppm, and 50 ppm of alum and 12 ppm of activated carbon are required to eliminate color and odors. With these increased amounts of chemicals filter runs are shortened 25 percent. When the exceptionally high color and odors recede and the heavy loads of activated carbon and alum are lessened, the filter beds are treated with caustic soda for a period of forty-eight hours and the coagulation basin is emptied and cleaned. This allows the filter runs to return to normal lengths.

Another objectionable condition arising from the flow of decayed

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vegetation into the reservoir is the formation of a stratum of stagnant water at the bottom, which imparts a high CO_2 content to the water to be treated. At one time at this reservoir, the CO_2 content was as high as 26 ppm. This problem of stagnant water was solved by opening the lower by-pass in the dam, allowing the bottom water to pass downstream and not through the plant.

During the third summer that this plant was in operation, the filter runs suddenly decreased to 25 per cent their normal length. Our consulting engineers were called in to help us to determine the cause of this trouble. They found it was a growth of algae in the reservoir, and they recommended the use of copper sulfate. Since that time, the temperature of the water is taken daily, and when it reaches the vicinity of 65° F. the reservoir is treated with copper sulfate every two weeks for the remainder of the summer or until the temperature falls below that which encourages the growth of algae.

In a plant that has automatic equipment, it is only reasonable to expect that some of it will fail to work as intended sometimes. One example is the failure of the solenoid that operates the pilot valve governing the opening and closing of the hydraulic valve that allows the reservoir water to flow by gravity to the coagulating basin. When the float in rising, opened the circuits to the solenoid, and to the alum, carbon and lime feeders, these feeders promptly stopped, but the little pilot valve remained stuck in the open position. The raw-water valve, not being closed, allowed the raw water to continue to flow into the coagulating basin. After two or three hours the coagulated water became so diluted with raw water, which entered without being chemically treated, that it passed through the filters to the clear water basin unchanged. This meant a correction of the entire plant in order to obtain the desired treatment. Upon investigating the trouble, we found that the contact part in the solenoid contained residual magnetism causing the pilot valve to remain stuck in the open position. This fault was overcome by filing creases across the surface of the contact. Since that time we have had no trouble with the solenoid.

Because of the automatic features of the Durham plant, attendance by an operator is needed only for two to six hours daily. All

electric contacts are checked periodically and a general inspection is made early in the morning and again in the late afternoon.

The last and perhaps the greatest problem that confronts all operators is the education of the people of this community to the value of chlorination of drinking water. This can be accomplished through written articles in the community newspaper on the use of chlorine in supplying a safe drinking water to the consumer.

NEW HAMPSHIRE'S APPROACH TO POST WAR PROBLEMS

BY EDGAR H. HUNTER*

[*Address presented May 18, 1944*]

As a member of the Public Service Commission of New Hampshire, I suppose I ought to say a word or two about the Commission, which has regulatory authority over water works, and comment perhaps on the Commission's point of view on water utilities. That, however, is not my subject and I do not propose to make more than a few passing remarks about the water utilities of the State of New Hampshire.

I recently went over the schedule of earnings of all water companies in the state and was struck by the lack of uniformity in water company reports. Values were not close to the average as they are in most other utilities, particularly electric utilities. Earnings ranged from red ink to 79 per cent.

The water companies, if I may be allowed to generalize, apparently know less about depreciation than almost any other group of utilities. On the other hand, I doubt if there are any better reports handed to us from any water or electric company than those that come from Manchester and Concord. We have some utilities, therefore, that are carrying on in the best tradition, and we hope to use them as examples.

My subject today is New Hampshire's approach to post war problems. New Hampshire has a rather individual approach, I believe, to most of its problems. One way in which we differ from other states is in the size of our appropriations. Either the Legisture is unmercifully tight or the Governor and Council are. I must not say too much about this, because I have been on the Appropriations Committee as chairman, clerk, and in other positions for a dozen years, so I must take my share of blame or praise. When Maine was appropriating $1,500,000 or $2,000,000 for defense, Vermont likewise,

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and Massachusetts 7,000,000, the Legislature of New Hampshire opened its heart and appropriated $5,000.

To the state's credit be it said, however, that New Hampshire did a grand job of civilian defense. We were one of the first states organized and we were the first state to demobilize and go onto a skeleton force. This was accomplished practically all with volunteer help, so perhaps there is something in our method of operation.

We have another old-fashioned idea in the State of New Hampshire. We somehow believe that borrowing money is not the end; that it has to be repaid. Hence it is against the law of the State of New Hampshire for any town to exceed its budget. Likewise in the state, the Legislature always balances its budget. We are paying off our state debt at the rate of $2,000,000 a year, so that our net debt is down to $7,000,000. In two or three years we will be out of debt. Perhaps there is a wholesome reason for the smallness of our appropriations.

On post war planning, we have no appropriation, except that of $2,500 given to us by the Governor and Council. Compared to Massachusetts' $750,000, and other states with similar amounts, this does not leave us financially in the running at all, but somehow, I believe, we will do a presentable job of post-war planning on a volunteer basis.

My enthusiasm for post war planning comes from my bitter experience of 1933 when I agreed, on a moment's notice, to comply with the request of Governor Winant and administer CWA. I found myself with $3,000,000 with no strings attached. I could spend that sum on public works for any political division of the state. I so notified the state. But there was a catch to it. I had to employ 12,000 men in a month from a standing start. Perhaps you gentlemen have had experience with a gang of men ready to go to work, and either the tool wagon didn't show up or there was no pipe or, what was worse, you hadn't any plans. That was the situation in which CWA caught us and, I suspect everybody else; $3,000,000 to spend, 12,000 people to employ, and no plans. I think I can truthfully say that this was the worst headache that I have ever had. For a month, I did not sleep nights wondering how I was going to put men in worthwhile

jobs, with not a plan in existence to work on. If it had not been for the State Highway Department, the Forestry Department, and the Fish and Game Department, I would have failed, but they came to my rescue.

As I see it, we may be facing a similar situation in the post war years, if we don't do some planning now. Those of you who are on post war planning committees, will not, I hope, experience the same disappointments that I have had. I have made the statement, and I think I would be justified in making it again, that planning will be the most over-used word in the English language by the time this war is over.

There is a chance, of course, that we won't need any post war planning for three years after the war. But who is ready to endorse that type of program; guarantee it; and say he would feel justified in doing nothing about it? Perhaps that chance is small, but it seems to me that we have got to keep faith with the people that have left our state, either in the armed forces or in war work, and for that reason there is nothing for us to do but go through this arduous program of post war planning.

The State of New Hampshire has recognized that and has said, "We will plan and prepare projects so that we can take care of re-employment. Beyond that, we will start on a six-year program, and we will discuss education, welfare, recreation, and all types of economic betterment, so that the impact of this war upon the economic interests of the state won't find us unprepared. We will attempt to have a plan ready, whatever the impact is."

On the immediate program that seems to be indicated, we have to do post war planning, and the State of New Hampshire has organized, as most other states have, on a work pile and a public works program. The public works, as everybody admits I think, should be used only when the work pile is insufficient to take up the slack in employment. The work pile is an infinitely more difficult job than public works, because it requires a survey of the various communities. All of this has to be done at the local level. A survey of the communities must be made by groups in those communities to find out what the employment possibilities are. Then the public works pro-

gram should be in the pigeon-hole in the blueprint stage, with specifications, so that it can be taken out, dusted off and put into operation in the shortest possible time, should the need arise.

We have attempted a survey of public works, inventorying and planning on water and sewerage works. We have heard from perhaps 25 per cent of the towns. They call for $250,000 for water works. I asked Percy Shaw what work Manchester had, and he said he could lay out a program of almost that amount in Manchester alone. I know, therefore, that there is a good deal of this type of work that is all ready for cataloging, but that we have to visit the towns and cities to get the information. The Planning Board, which is assisting the Post War Council, has asked the Governor and Council for funds to put personnel into the field to contact the various cities and towns, both on work pile and on public works.

The state is fairly well provided with water works, but there may be need for extensions. I have always wondered if there could not be closer connection in the engineering of water works and sewerage works. We have no difficulty, in general, in selling the need of water works to towns and cities, either by municipal companies or utilities. Everybody admits that we have to have water. But sewerage always comes about as an afterthought. Perhaps there is a psychologically unfortunate association in mentioning sewers at the same time as water. But one follows the other just as sure as night follows day. The next thing that follows is some treatment of the sewage. When I came into New Hampshire forty-odd years ago from Massachusetts, I had been in the Sewer Department of the City of Somerville and made the connections to the Metropolitan Sewerage System at that time. I found the State of New Hampshire was busy putting in water systems, but nobody in the small towns had thought of sewers. My first job at Dartmouth College, where I was a student, was building sewers for the college. They had recently built a water works, and inevitably found that they must have sewers.

As Chairman of the Committee on Public Works of Post War Planning, with the thoughts I have about sewage disposal and sewers, I believe that we should capitalize the necessity of the post-war years and do something about sewerage. There is hardly a city

or town in New Hampshire that has done much about sewerage. Massachusetts is definitely getting ready to brand us as a poor neighbor because we dump all of our sewage into the Connecticut River and the Merrimac River. And Maine, I understand, is getting fussy because we are dumping sewage into the Androscoggin and the Saco. So it just becomes an interstate necessity, if for no other reason, that we should do something about it. Then, too, the Great Bay, that extends almost to Durham, has just been declared unfit for the taking of shellfish because it is a cesspool for ten or a dozen towns and five cities in its area.

There is a great chance for us as a state to take advantage of post-war planning, when people are willing to spend money to be prepared, at least, to go as far as need be to relieve unemployment. I shall be very much surprised if, at its next session, the Legislature is not asked for authority to provide engineering designs for the eradication of sewage pollution for the whole state.

This plan should be without Federal aid, because we have found out by experience that for every Federal project we pay real tax dollars, to get one back, and then the Federal Government tells us how to spend that dollar. All our post-war planning in the State of New Hampshire, at least, as far as it has progressed, is *sans* Federal aid.

The program is just starting, although we have been at it for a year. Its slow start, I hope, is no measure of the final program. Out of the entire public works basket I would suppose we might have something like $20,000,000 in the state as a post-war nestegg.

Now I would like to ask the members of this Association from New Hampshire if they won't contact Mr. Sanders of the Concord Water Company, who is a member of the Public Works Committee of the Post War Planning, to list the water works projects that they know of. We had the request from either this Association or the New Hampshire Association to have a member of the association on our Committee, and we were delighted to comply. It was most encouraging to find that this group was with us. Of others, I solicit aid in all post war planning, both in the work pile and the public works, because in no other way do I feel that we can look the returning vet-

eran in the face, truly welcome him back and show him that we are delighted to see him and have a job for him. From what I have learned, there are no other words after the first greeting that will be quite so welcome as these: "When are you ready to go to work?"

Discussion

The President. At the last meeting of the Maine Water Utilities Association there was some discussion as to the placing of sewerage works under the same control as water companies. I would like to ask you if that would necessitate legislation in New Hampshire.

Mr. Hunter. I think very likely legislation is necessary. I do not wish to be misunderstood when I advocate the same relationship between sewerage, be it municipal or private, and the Public Service Commission that now exists for water companies. I think we are in a position to help establish sewerage systems and disposal plants on a sound accounting basis. An enabling act was passed at the 1941 Legislature which gave to Portsmouth, Laconia, and Concord a right to charge sewer rentals. This was, to my mind, wise legislation. The City of Concord came to our office and asked if we would like to establish a system of accounting, and we told them that, while we had no jurisdiction, we would be glad to help them. They accepted our offer, so the accounting on the Concord sewers is practically on the same basis as that on the water supply. The charges are based on the water meter readings.

In that legislation, which undoubtedly will be extended at the next session, and in the acceptance of it by cities and towns, I see the most hopeful sign for pollution eradication. It is going to cost money. It has to be financed through bonds. According to our old-fashioned New England custom, somebody has to pay for those bonds on maturity, and what could be sweeter than getting a sewer rental system established to pay off the bonds when they come due? It is going to be difficult, because people are accustomed to get the use of the sewer for nothing and they will expect this to continue if we don't start educating them *now*.

CHLORINE DIOXIDE—A NEW DEVELOPMENT IN THE TREATMENT OF POTABLE WATER

BY JOHN F. SYNAN, J. D. MACMAHON, AND G. P. VINCENT

[*Read September 21, 1944.*]

THE chemical disinfection of public water supplies in this country is hardly forty years old. In this time, the use of chlorine gas or of hypochlorites in water treatment has become standard practice throughout the United States. Now this treatment can be supplemented by utilizing the powerful oxidizing gas, chlorine dioxide, ClO_2.

Chlorine dioxide, because of its instability, cannot be produced in bulk and stored until wanted; it must be generated in very low concentrations at the point of use, and consumed immediately. This was not feasible until recently, chiefly because of the difficulties inherent in the accepted method of generating the gas by reacting potassium chlorate with sulfuric acid. This method is low in production efficiency, does not give a pure product, gives rise to serious corrosion troubles, and is difficult to control.

A new source of chlorine dioxide was made available a few years ago when sodium chlorite, $NaClO_2$, was introduced commercially. Pure sodium chlorite is a white powder, stable both in the solid state and in solution. It is intermediate in properties between hypochlorite and chlorate, and contains 158 per cent available chlorine. The commercial product is flaked and contains approximately 75 per cent chlorite.

Several methods have been developed to prepare chlorine dioxide from sodium chlorite.

The earliest of these was an electrolytic method (1) based on the reaction:

$$2NaCl + 2NaClO_2 + 2H_2O \xrightarrow{2\ \text{Faradays}} 2ClO_2 + 2NaCl + 2NaOH + H_2$$

This process produces chlorine dioxide under satisfactory conditions for certain uses (2), but requires complicated equipment. It was

*The Mathieson Alkali Works Inc.

therefore abandoned when simpler and purely chemical processes were introduced. The first of these chemical processes (3) was based on the fact that when chlorine is introduced into a solution of sodium chlorite, the following over-all reaction takes place at room temperatures:

$$2NaClO_2 + Cl_2 \longrightarrow 2NaCl + 2ClO_2$$

This process, utilizing suitable control, measuring, and safety devices, is practicable.

Recently a method of generating chlorine dioxide by treating dry sodium chlorite with chlorine has been developed (4). A mixture of chlorine and air is passed through two towers, lined with stoneware, and filled with flake sodium chlorite, and chlorine dioxide is formed in accordance with the reaction just stated. Control of the air and chlorine supplies regulates the amount of chlorine dioxide formed (5).

For many processes, this dry method is superior to the wet process. In the treatment of water supplies, however, the wet method is more applicable. The most practical method for generating chlorine dioxide for water treatment consists in feeding a sodium chlorite solution into the discharge line of a Wallace and Tiernan chlorinator and passing the mixture through a mixing chamber to complete the reaction.

Properties of Chlorine Dioxide. At ordinary temperatures and pressures, chlorine dioxide is a yellow to red, unpleasant smelling, irritating gas, with a vapor density of approximately 2.4. The odor of chlorine dioxide is evident at 14 to 17 ppm, and at 45 ppm it is irritating. At room temperatures, it is soluble in water to the extent of 2.9 grams per liter of chlorine dioxide at 30 mm. partial pressure. Its aqueous solutions are decomposed by light.

The oxidizing power of chlorine dioxide, stated in terms of "available chlorine," is two and a half times that of chlorine itself. This is illustrated on a molecular basis as follows:

$$ClO_2 + 2\tfrac{1}{2}H_2 \longrightarrow HCl + 2H_2O$$
$$Cl_2 + H_2 \longrightarrow 2HCl$$

Chlorine Dioxide for Water Treatment. The development of a practical method for generating chlorine dioxide led to investigations

of its use in water treatment for the destruction of tastes and odors due to phenolic wastes or algae and for sterilization.

Bactericidal Action. Chlorine dioxide, in our experience, is a more effective bactericide than chlorine when tested on distilled water to which *E. coli* have been added. When used on polluted water, however, chlorine dioxide, because it is much more reactive than chlorine, destroys phenols, algae, and other contaminants at the same time that it attacks bacteria. For this reason, the disinfection of polluted waters requires more chlorine dioxide than chlorine. This conclusion, stated by McCarthy (7), was borne out in a series of experiments using the following waters:

a. Merrimac River—Tap water from Lawrence, Mass.—culture of *E. coli* added
b. Merrimac River—Untreated—filtered only
c. Niagara River—Tap water from Niagara Falls— culture of *E. coli* added
d. Niagara River—Untreated—filtered only
e. Ohio River—Untreated—filtered only—from Cincinnati

The results of these experiments to determine the comparative amounts of chlorine and chlorine dioxide required to disinfect these waters are outlined in the following table:*

Water	*Coliform Index of Sample*	*ClO_2 ppm** for Complete Disinfection*	*Cl_2 ppm** for Complete Disinfection*
(a)	1,000,000	2.0	0.50
(b)	100,000	2.4	0.8 -1.0
(c)	1,000,000	0.6	0.6
(d)	100,000	1.4	0.8
(e)	100,000	1.2	1.0

A comparison of the demand of these waters, in terms of residual chlorine, is shown below:

Water	*ClO_2 Demand*	*Cl_2 Demand*
(b)	1.99	0.66
(d)	1.01	0.66
(e)	0.89	0.65

The basic chlorine demand of various waters remains fairly con-

*Procedures as outlined in "Standard Methods of Water Analysis" were used throughout this work.
**Listed as ppm available chlorine.

stant, since the chlorine destroys bacteria primarily. The chlorine dioxide demand, however, if used for disinfection, varies with the degree of pollution, since the chlorine dioxide reacts more readily with other contaminants than does chlorine.

Taste and Odor Control. For the improvement of taste and odor, chlorine, as ordinarily applied, has not been found to be entirely satisfactory, especially where phenolic pollution or considerable algae growths occur. The breakpoint method of chlorination, developed for this purpose within the past six years, is not always adequate. Where sharp breakpoints fail to occur, or where sudden fluctuations in pollution tax the chlorinator beyond its capacity, temporary shut-downs, or even new sources of water supply, become necessary.

Such a situation existed in an auxiliary filter plant of the City of Niagara Falls Water Department. This plant, which supplies 3 to 8 mgd, or about 10 to 20 per cent of the total water supply, has an "on-shore" intake which becomes so polluted, at some times with phenolic compounds, and at other times so infested with algae, that the ordinary method of treatment often failed to produce a palatable water. This condition is intensified by the fact that phenolic pollution comes in surges rather than at a constant rate, so that the water varies greatly even from hour to hour.

Experiments undertaken at Niagara to study the possibilities of chlorine dioxide as a solution to this problem have demonstrated that chlorine dioxide destroys such tastes and odors (6).

Because information on the bactericidal action of chlorine dioxide is still incomplete, it was considered inadvisable to attempt to replace the chlorine now used for disinfection of the water. The method as developed at Niagara, therefore, combines pre-treatment with chlorine for disinfection and treatment with chlorine dioxide to destroy tastes and odors.

In the pre-treatment, enough chlorine is fed to maintain a residual available chlorine of 0.4 to 0.5 ppm in the settling basin, and 0.2 ppm under the filters. This residual was regulated at first in the usual manner, by the addition of carbon. Subsequently it was found that the use of carbon was unnecessary. The residual now being maintained simply by regulating the chlorine feed. A dosage of 1.5 ppm

of chlorine is ordinarily sufficient for the purpose, but is increased when the demand of the water increases.

Along with addition of chlorine, alum is added for clarification. Usually, 17 ppm of alum is sufficient, and the water is held in the settling basin for three hours. Following this treatment, chlorine dioxide is introduced at the clear well. This is accomplished as follows:

The sodium chlorite solution, containing 31 grams per liter of available chlorine, is fed by means of a metering pump into the discharge line of a Wallace and Tiernan chlorinator, at the rate of 1.65 gallons of solution, or 0.42 pound of available chlorine, per hour. The chlorinator is set to deliver two pounds of chlorine per million gallons, equivalent to 0.25 pound of chlorine per hour at a pumping rate of three million gallons per day. To assure complete conversion of chlorite to chlorine dioxide, an excess of chlorine is used. The reaction mixture is passed through a mixing chamber before entering the well. The chlorine dioxide dosage is maintained at a value of 0.5 to 0.75 ppm of available chlorine.

During the test runs, the concentration of phenol in the river was very high. Breakpoint tests in the laboratory indicated that, with the old method, doses of 15 ppm of chlorine would have been required in some cases; and, on at least one occasion during the test period, the plant would not have been able to feed enough chlorine to handle the load, and would have been forced to shut down.

While the taste-and odor-producing substances at the time of the initial tests were chiefly phenolic, since this is the characteristic difficulty of the Niagara water supply during the winter months, the taste and odor difficulties during warm weather are mainly the result of algae growths. Chlorine dioxide treatment eliminates both difficulties, efficiently and completely.

The entire water supply system of the city of Niagara Falls is now protected by chlorine dioxide treatment, to give year-round operations without taste and odor difficulties. It has been found, also, that a considerable saving in chemical costs is obtained by the use of the new method. On the basis of one week's operation, the comparative costs are:

OLD METHOD		*NEW METHOD*	
1080 lb. chlorine		162 lb. chlorine	
1800 lb. carbon		46.2 lb. chlorite	
Total cost	$157.50	Total cost	$43.10
Cost per million gallons	$ 8.73	Cost per million gallons	$ 2.39

The saving per million gallons over the old method of treatment, therefore, is $6.34, or 72.5% In addition to the saving in the cost of materials, plant operations are simplified by the elimination of careful breakpoint measurements.

Summary. 1. A new method for the treatment of water has been described.

2. This method involves pre-treatment of water with chlorine to disinfect it followed by treatment with chlorine dioxide to destroy tastes and odors due to algae or phenolic wastes.

3. The new treatment permits continuous operation, reduces the amount of chlorine required, eliminates the use of carbon, and simplifies operation by making breakpoint measurements unnecessary.

4. Chlorine dioxide has also demonstrated bactericidal action, the dose required for disinfection varying with the degree of pollution.

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WATER-DISINFECTING TABLETS

BY G. M. FAIR, R. P. BURDEN, G. H. CONANT, AND J. C. MORRIS*

[*Read September 21, 1944.*]

THE purpose of water-disinfecting tablets is to render safe from infection small amounts of water that are collected from sources of doubtful purity by hunters, fishermen, boy scouts, mountain climbers, explorers, prospectors, and travelers in foreign lands, as well as by small military detachments away from their base. To be widely useful, such tablets must meet many and varied specifications, all of which are predicated on the fact that the tablets are, of necessity, the only means at the disposal of the individual user to ensure the safety of the small amounts of water that he collects from available sources. None of the additional methods of water purification—coagulation, settling, filtration, and the removal of odors and tastes—can be conveniently employed; neither are there means for testing water quality nor for adjusting the dosage beyond the choice of one or more tablets after visual inspection of the supply.

The specifications that must be met may be summarized as follows:

1. The tablets must disintegrate or solubilize rapidly when they are dropped into the water that is to be disinfected.
2. They must liberate their active ingredient or ingredients quickly whether the water is allowed to remain quiescent or is stirred vigorously.
3. They must destroy all significant disease-producing organisms contained in the water in a short period of contact.
4. They must be effective in all kinds of natural waters.
5. They must not impart undesirable qualities to the water.
6. They must maintain their strength in storage and use.

Distintegration. Tablets that are to be ingested need not contain disintegrating or solubilizing substances. Warmth, motion, and active body fluids will in time break up even the most fractious pill.

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Tablets that are to disinfect water, on the other hand, must contain disintegrating solubilizing substances if they are to be effective in a reasonable length of time.

Most tablets contain talc. This substance is added to the mixture to lubricate the punches of the tablet machine. Calcium or magnesium stearate are sometimes added instead. If a diluent is needed to give the tablets adequate bulk, table salt is widely used as a filler or excipient in pharmaceutical practice. For water disinfection, sodium chloride has the disadvantage that it "sets up" or hardens the tablet with age. Rapidly soluble nitrates, phosphates, acetates, and sulfates are better. The diluent should preferably be soluble so as to preserve the clarity of the treated water. At the same time it should not be hygroscopic and should be inert to the active ingredients, cheap, and not in itself therapeutic.

Disintegration of tablets is promoted by including swelling agents in the mixture. Here bentonite is useful. This colloidal clay is chemically inert but physically very active. It swells quickly in water and causes the tablet to burst. Starch, otherwise an ideal swelling agent, is not inert to halogens and cannot be used in water-disinfecting tablets that contain halogens.

If the activity of the disinfecting ingredients is promoted by the reaction of the water, buffering agents are included in the tablet mixture. Generally this is done by making the filler serve as a buffer. Certain phosphates are ideal for this purpose. By proper selection, a wide range of moderate acidity or alkalinity can be induced in the water. With the halogens, best results are obtained with weak acids of strong buffering power.

A satisfactory tablet, therefore, contains a mixture of compatible ingredients including the active chemicals, the swelling agent, and the filler which, if need be, should possess the desired buffering properties.

Liberation of Active Ingredients. Two types of tablets have shown possibilities in water disinfection: those contaning active chlorine attached to a nitrogen atom (of the general formula $R_2 = N — Cl$ or $R — N = Cl_2$) and those containing idodine. So far as the first class is concerned, the disinfecting power seems to

be directly proportional to the extent to which the reactions of hydrolysis

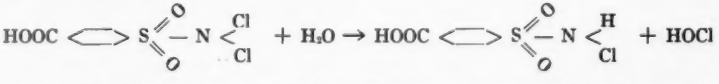
$$R_2 = N - Cl + H_2O \rightarrow R_2 = N - H + HOCl$$

$$R - N = Cl_2 + H_2O \rightarrow R - N \begin{matrix} H \\ < \\ Cl \end{matrix} + HOCl$$

proceed in solution. None of the compounds are active in themselves; the HOCl liberated by hydrolysis is the disinfecting agent.

It should be noted that, at the concentrations employed in water treatment, chlorine itself exists practically completely in the form of HOCl. As a result, the problems of chlorine demand and reaction with nitrogenous matter are identical for the tablet compounds and for chlorine itself. Also, just as with chlorine itself, the efficiency of disinfection is greatly reduced at higher pH values, because the hypochlorous acid is neutralized to hypochlorite ion which is not disinfecting.

As an example of these N-chloro compounds, Halazone (p-dichlorosulfamido-benzoic acid) liberates only one-third of its active chlorine as HOCl. The reaction is



and sixteen milligrams, at least, of Halazone are required to produce 2.5 mg of free HOCl.

In comparison with chlorine, iodine is not appreciably hydrolized in acid solution at the concentrations employed in the disinfection of water. Hence it acts as molecular I_2 or in the form of I^-_3 ion. These seem to be equally effective. The mechanism of action of iodine is apparently different from that of HOCl and its efficiency is not affected by the presence of nitrogenous pollution.

Tablets containing active iodine are of two kinds: those which depend upon chemical reaction to release the iodine and those in which the iodine exists as triiodide ion. So far as the first class is concerned, the efficiency and rate of reaction depend very much upon the manner in which the tablet is dissolved.

For example, tablets containing potassium iodide, potassium iodate mixtures together with an acidic material depend on the reaction

$$5\,KI + KIO_3 + 5\,H^+ \rightarrow 3\,I_2 + 3\,H_2O + 6\,K^+$$

for development of disinfecting power. This reaction is very strongly influenced by concentration, and consequently an adequate liberation of iodine can be obtained only when the dissolving material is allowed to form a "pool" of concentrated solution about the tablet. If the container is shaken during solution, practically no iodine is freed. Furthermore, in this particular case, the reaction is reversible and will give a substantial yield of iodine only at pH 5 or lower.

Bursoline (diglycine hydriodide) is an example of compounds in which the iodine exists as triiodide ion. Its formula may be written as

$$I^-_3\ NH_3^+\ CH_2\ COOH(NH_2CH_2COOH)$$

The iodine is thus all inorganic in nature and is automatically free to disinfect as soon as the tablet is dissolved, since the iodine is already present in the elemental condition.

Destruction of Pathogens. For worldwide use, water-disinfecting tablets must be able to destroy, during a reasonable period of contact, at least four kinds of organisms of possible significance in the spread of water-borne disease: bacteria, protozoa, worms, and viruses. Representatives of all four groups can be recovered from the excreta of persons acutely ill or from carriers.

The bacterial infections include typhoid fever, bacillary dysentery, and cholera. Most of our conscious efforts in the disinfection of municipal water supplies have been directed at the destruction of these organisms. The protozoal infections, among which amebic dysentery is of widest significance, increase in importance as the standards of community sanitation are lowered. The great resistance of the cysts of *E. histolytica* to destruction by chemical agents, in fact, establishes the destruction of amebic cysts as the limiting criterion of the general usefulness of water-disinfecting tablets. Among the parasitic worms, the schistosomes, or blood flukes, rather than the pinworms, hookworms, roundworms and tapeworms, are the most important, because water is an essential element in the spread of schistosomiasis. Infection, however, is through the skin, rather than the alimentary tract. The cercariae of the schistosomes, however, are less resistant to the halogens than are the cysts of *E. histolytica*. About the role of water in the spread of virus infections we are

still in the dark, and the effectiveness of the halogens in destroying a virus such as that of infantile paralysis has not yet been satisfactorily established.

In otherwise clean water, the destruction of living organisms by chemicals is a function of the number of organisms to be destroyed, the concentration of the active chemicals, and the time of contact between the two. Because water-disinfecting tablets are to be used by persons who will seldom appreciate that time is of the essence of the reaction, the quicker disinfection is completed the more foolproof do the tablets become. Attainable periods represent a compromise between requisite chemical dosage and its effects upon the palatability of the water. The water must remain fit, and desirably satisfying, to drink. A contact period of ten minutes or less seems to be a possible goal. To attain it, doses ordinarily associated with superchlorination and similar weights of iodine must be applied, *i.e.*, halogen residuals of about 5 ppm.

Effectiveness in Different Waters. In addition to the number and variety of pathogens they harbor, the properties of natural waters that are significant in their disinfection are: temperature, pH and alkalinity, halogen demand, and halogen conversion.

Warm water is more quickly disinfected than cold water. Warmth promotes disintegration and solution of tablets and accelerates chemical and biochemical activities, so that the overall effect is compounded. If we base temperature effects on the rate of solution of the active chemicals together with the rate of destruction of amebic cysts, we find that within the range of natural water temperatures the required contact time must be lengthened to the order of about fifty per cent for each drop in water temperature of ten degrees centigrade. At 10°C, therefore, the contact period must be 1½ times as long as at 20°C, while at 0°C it must be 2¼ times this value. Reports on the efficiency of disinfecting tablets should, therefore, always specify the temperature at which experiments were conducted.

As stated in connection with the N-chloro compounds, the effect of pH and alkalinity are very marked when disinfection is dependent on the formation of HOCl. This is equally true for bleaching powder, hypochlorites, and chlorine itself. Bleaching powder and

hypochlorites contribute to this effect by releasing alkaline by-products in their hydrolysis. This explains the otherwise anomalous result that over short contact periods disinfection is sometimes not improved by increased dosage. For most effective use of a single tablet, i.e., without correction of the pH by a supplementary tablet, a pH value of about 6 is desirable, or at least one less than 7.

In colored waters, dissolved tannins and humic acids exert an appreciable halogen demand which appears to be greater at high pH values than in acid solutions. Chlorine demand and iodine demand are found to be of the same order of magnitude on a weight basis. Waters containing nitrogenous matter convert hypochlorous acid and chlorine to chloramines. No similar conversion of iodine takes place, however, and this constitutes one of the advantages of iodine compounds in the disinfection of sewage-polluted waters. The slow rate of action of chloramines in comparison with HOCl is a distinct drawback when the contact time is to be short.

Undesirable Effects on Water Quality. Among these we may list odor and taste, color, turbidity, foaming, and, most important, toxicity. The first four render water unsavory, the last renders it unsafe.

Some odors and tastes are generally produced by the disinfecting compound itself or by products of its reaction with substances already present in the water. Chlorphenols resulting from the chlorination of water containing traces of phenolic wastes are examples of produced rather than induced tastes. Similar objectionable medicinal tastes occur also when iodine is substituted for chlorine. Tastes of the disinfectant itself vary at different pH values. It is a stroke of luck, therefore, when minimum odors and tastes coincide with optimum pH values.

The staining of otherwise colorless waters is marked when iodine is added. Turbidity and opalescence are imparted by swelling agents, such as bentonite and by insoluble residues, or products of reaction, of the active ingredients. On the whole, color and turbidity in the concentrations normally induced by disinfecting tablets are of minor importance, however.

Foaming and sliminess accompany the addition of detergents

such as the quaternary ammonium compounds. These surface-active substances are newcomers to the field of water disinfection. They possess both bactericidal and cysticidal properties and have, so far, been employed in dishwashing rather than in drinking-water treatment. How toxic they are in the required concentrations remains to be established.

The possibility that untried disinfectants are toxic or that they produce otherwise undesirable physiologic responses in the quantities in which they are ingested when they are used to disinfect the maximum water intake of individuals must be carefully scrutinized. Idiosyncrasies of rarer occurrence, too, must be taken into consideration whether they appear in otherwise normal persons or are associated with definite illness. The possible reactions to iodine constitute a case in point.

Ingredients other than the active disinfectants must be suspect as well. Borates which are often desirable components of tablets, because of their buffering effects and their usefulness as soluble aids to manufacture, are toxic in higher concentrations.

Keeping Qualities. The properties of rapid disintegration and reaction in the presence of moisture, which water-disinfecting tablets must possess, militate against their successful storage and the maintenance of their strength during use. The problem to be solved is one of finding compounds that will not only remain unimpaired in sealed containers over long periods of time while they are being shipped or carried to their points of use or while they are being stocked for application during emergencies, but that will also keep substantially their full strength while the contents of the container are being used up. High temperatures and humidities are the forces against which the maker must contend.

Glass containers with plastic caps and suitable cap liners provide good protection against moisture over considerable periods of time. Bonding the cap to the glass with a waterproof wax gives additional insurance. Vials should contain the smallest number of tablets consistent with their use during a reasonable period of time after the container has first been opened.

For the user of small numbers of tablets, there are ways of

sealing individual tablets into metal or paper envelopes that will neither permit moisture to reach the tablet nor the tablet to destroy the envelope. The choice of stock and coatings depends upon the nature of the tablet that is to be protected.

Closure. In the course of the last generation we have learnt to demand that except for unusually well-protected groundwaters, all public water supplies should be disinfected. Much thought has been devoted to developing suitable ways and means for accomplishing this task at the municipal level. During the same period but little advance can be charted, on the other hand, in providing the individual with a water-disinfecting tablet that he can use with assurance when he must drink water from an unprotected source. This paper has been written to point out the nature of the problem and to stimulate interest in the development of water-disinfecting tablets that will meet the specifications here outlined.

PROCEEDINGS

MAY 1944 MEETING
UNIVERSITY OF NEW HAMPSHIRE
Durham, N. H.

Thursday, May 18, 1944

President Horace L. Clark presiding.

The Association was welcomed to the University of New Hampshire by Dean M. Gale Eastman.

Secretary Gifford announced the following elections.

Members: Theodore B. Brink, Superintendent, Water Department, Plymouth, Mass.; Royal J. Goddard, Water Department, Registrar and Clerk, Gardner, Mass.; Karl Haartz, Field Water Supply, U. S. Army, Andover, Mass.; Gilbert E. Long, Superintendent, Fairhaven Water Company, Fairhaven, Mass.; and John L. Ossolinski, engineer with Whitman & Howard, Inc., Boston, Mass.

Corporate Members: Portland Water Works, Portland, Conn.; and Lewiston Public Works Department, Lewiston, Me.

Associates: Ampco Metal, Inc., Milwaukee, Wis.; and Bridgeport Brass Co., Bridgeport, Conn.

The Secretary announced the deaths of Hugh McLean, Chairman of the Board of Water Commissioners of Holyoke, Mass., and of Frederic H. Fay, Consulting Engineer, Boston, Mass.

An address on "New Hampshire's Approach to Post War Problems" was given by Edgar H. Hunter, Chairman, Public Service Commission of New Hampshire.

An address on "Uniting the Nations" was given by Dr. Herbert F. Rudd, Professor of Philosophy, University of New Hampshire. This was discussed by Harold W. Griswold and Percy A. Shaw.

U. S. Army Sound Films were shown.

OBITUARIES

HORACE JOSEPH COOK

Horace J. Cook, Superintendent of the Auburn Water and Sewerage Districts, died following a heart attack on October 18, 1943. He was born in Burnham, Maine, on February 23, 1885, of a long line of staunch Maine people and inherited qualities of strength and kindliness and a rigid conviction of right living which marked his entire life.

After preparation for college, he entered the University of Maine in 1906 where he starred in football and track, earning thirteen letters in sports. He captained the 1909 football team and the 1910 track team, graduating with honors in 1910 with a degree of Civil Engineering. Following graduation, Horace Cook was employed by John Burleigh of Waterville as an engineer, later becoming valuation engineer for the New York Central and Atlantic Coast Lines Railroads. Shortly before the outbreak of World War I he became Assistant Superintendent of the Kennebec Water District of Waterville, later serving as Captain of Infantry, United States Army, in charge of utilities in Camp Cody, New Mexico. In 1919, he went to Auburn as Superintendent of Highways and was City Manager from 1920 to 1922, when, upon the organization of the Auburn Water and Sewerage Districts he was appointed Superintendent of both organizations.

In the civic and fraternal life of his community he was very active, being a member of the Blue Lodge and St. Omer Commandery of Waterville, the Auburn Shrine, and the American Legion. He was founder and president of the Men's Club of the Elm Street Church in Auburn, a corporator of the Mechanics Bank and a trustee of the Auburn Building and Loan Association.

Horace Cook was always willing and anxious to share his knowledge with others, lecturing for many years in Sanitary Engineering at the University of Maine and instructing classes in mathematics in

Auburn under the Technical Training Program of the U. S. Department of Education.

He was active in the affairs of the American and New England Water Works Associations, being a member of many committees of each. When the Maine Water Utilities Association was organized in 1925, he was one of its most enthusiastic promoters and was Secretary, Treasurer and Editor until 1932, besides being a member of and chairman of a majority of the committees of the Association. His attendance record was unbroken for more than eighteen years.

Surviving him are his wife, a sister, Mrs. Howard O. Burgess of Augusta, and two brothers, Carleton P. and George R. Cook.

Horace Cook became a member of the New England Water Works Association on September 9, 1914.

SIDNEY S. ANTHONY

SAMUEL MORRISON ELLSWORTH

Samuel M. Ellsworth, Consulting Engineer, of Boston, Mass., died on Sunday, August 13, at a rest home in Brattleboro, Vermont, following a severe nervous breakdown suffered last April. He is survived by his widow and two young sons.

Samuel Ellsworth was born at Braintree, Mass., January 4, 1895. After attending the local schools, he obtained his engineering education at the Massachusetts Institute of Technology, from which he graduated in 1916.

After two years on sanitary and drainage surveys for the Massachusetts State Department of Health and for the American Red Cross and U. S. Public Health Service, he entered the Army in July 1918 as a private and was later commissioned 2nd Lieut. in France. Here he served with a mobile water purification unit in the First Army, A.E.F., and as Area Water Inspector at the American Embarkation Center at Le Mans.

Upon leaving the Army, he worked for four years principally in consulting engineering offices, including those of Morris Knowles, Inc., in Pittsburgh, and Weston & Sampson in Boston, and for three years as Assistant Engineer, first with the Massachusetts Depart-

ment of Public Health and later with the North Jersey Water Supply Commission. In 1926, he became Senior Assistant Engineer with Metcalf & Eddy in Boston where he remained for five years.

In 1932, after a trip to Europe to study sanitary works there, he started his consulting practice, first at 12 Pearl Street and later at 6 Beacon Street, Boston, specializing in municipal and industrial water supply, sewerage, sewage and waste disposal, and general sanitation. His work chiefly included investigations, reports, design, and supervision of construction of water supply and sewage treatment works for New England municipalities. During the war, either in his own name or in collaboration with others, he was employed on work for the Army and Navy on the camps and bases at Camp Edwards, Weymouth Lighter-than-Air Base, Naval Advance Base Depot at Davisville, R. I., Camp McCain at Granada, Miss., and for industrial plants at the Holston Ordnance Works at Kingsport, Tenn., and Pratt & Whitney at East Hartford, Conn.

In 1934 and again in 1936, he was water consultant to the National Resources Committee on river and harbor sanitation in New England. In 1935 and 1936, he was a member of the Boston Works Projects Board to develop employment relief projects for that city.

At the time of his death, he was one of the consulting engineers for the Metropolitan District Water Supply Commission on the study of sewage disposal for the South Metropolitan area; he was Lecturer on Sanitary Engineering Design in the Graduate School of Engineering of Harvard University; and he was Chairman of the Sewer Commission of the Town of Braintree, an office to which he was first elected in 1934.

Samuel Ellsworth was a member of the American Institute of Consulting Engineers, American Society of Civil Engineers, Boston Society of Civil Engineers, American Water Works Association, American Public Health Association, New England Water Works Association and the New England Sewage Works Association. He was a Past President of the Northeastern Section of the American Society of Civil Engineers and of the New England Sewage Works Association. At the time of his death he was President of the Boston Society of

Civil Engineers and nominee for Director of the New England Water Works Association.

Samuel Ellsworth was the author of many papers for engineering magazines and societies. His paper published in the New England Journal of Medicine in 1940 entitled "Can Infantile Paralysis Be Spread by Bathing in Sewage-Polluted Waters?" raised for the first time a question which has since been considered of increasing importance. Always interested in the welfare of the profession and the public responsibilities of the engineer, he wrote wisely on these subjects, too.

Samuel Ellsworth was an indefatigable worker who never spared himself when a job had to be done, particularly on work which was a part of the war effort, such as that connected with the construction of Camp Edwards. A ready grasp of the essentials of an engineering problem, willingness to give adequate analysis, clear-cut judgment leading to the final solution, and directness in execution characterized his work. He possessed a high sense of the duties of his profession, and absolute sincerity and integrity; these he expressed with straightforwardness that made clear his position on any given subject. There was always, however, an underlying sense of humor maintained even under the trials which are at times the lot of the professional engineer. His death so early in his career has deprived the engineering profession of a man who represented its finest type and those who knew him of a congenial and valued friend.

Samuel Ellsworth became a member of the New England Water Works Association on February 8, 1935.

HOWARD M. TURNER
GORDON M. FAIR

CHARLES EDWARD GREENE

Charles E. Greene, a member of this Association since March 1936, died at his home in Winchester, Massachusetts, on March 6, 1944. He was born in Dorchester on February 8, 1889, a son of Charles A. and Caroline (Blackmer) Greene. He married Christine Everts in 1917 by whom he is survived. He also leaves four

daughters, Emily, Mrs. Eleanor Smith, Margaret, and Mrs. Dolly Elizabeth Peach, and two sons, Stephen and Charles Edward, Jr.

Charles Greene was educated in the Boston public schools and the Massachusetts Institute of Technology from which he was graduated in 1910. After graduation, he was employed by E. B. Badger and Sons Company of Boston from 1910 to 1927. While with this Company he was successively assistant factory superintendent, factory superintendent, and chief designer of power plant equipment. In 1927, he became mechanical and electrical engineer for Metcalf & Eddy of Boston, engaged in the design of pumping plants and mechanical and electrical equipment for water works, sewage treatment plants, municipal refuse incinerators and power plants. In 1937, he became associated with the firm of Cleverdon, Varney and Pike of Boston, as consulting engineer on design of mechanical and electrical work of that firm. In addition to his regular work, during the past two years of his life he was a special lecturer on mechanical equipment for buildings at the Graduate School of Design at Harvard University.

While a member of this Association he presented two papers on the pumping of water which are published in the JOURNAL. He was also a member of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Alumni Council of M.I.T.

Charles Greene was active not only in his profession but in the civic affairs of Winchester. From 1918 to 1930 he was active in the Boy Scouts. He was a member of the Winchester Town Finance Committee, chairman of the original committee which planned the improvements to the Town's waterways, and for the past twelve years of his life was Treasurer of the Winchester Hospital. He was a member of the First Congregational Church of Winchester and participated in its activities.

"Charlie" Greene was a hard and conscientious worker. Each problem with which he was confronted was studied with extreme thoroughness until he could satisfy himself as to the correctness of the solution. His standards of professional ethics were high, and his dealings with clients and with other engineers were marked with

keen appreciation of his responsibilities. His personal life was marked by love of family and loyalty to his friends. Those who were privileged to work with him will remember him with affection.

Charles Greene became a member of the New England Water Works Association on March 19, 1936.

E. SHERMAN CHASE

PAUL HANSEN

Paul Hansen died February 6, 1944, after a brief illness. His death closed a career, 41 years long, of sanitary engineering practice.

Paul Hansen was graduated from the Massachusetts Institute of Technology in 1903 with the degree of Bachelor of Science in Sanitary Engineering. In 1903-04 he was an assistant engineer in the Massachusetts State Department of Health; in 1904-05 he was assistant engineer on the design of water supply and sewerage improvements at Columbus, Ohio; in 1905-06 he was chief engineer of the Pittsburg Filter Manufacturing Company; from 1906 to 1910 he was assistant engineer and chief engineer of the Ohio State Department of Health; during 1911, while chief engineer of the Kentucky State Department of Health, he established an engineering bureau and water and sewage laboratories for the department; from 1912 to 1915 he was chief engineer of the Illinois State Water Survey and lectured on sanitary engineering at the University of Illinois; from 1915 to 1917 he was chief engineer of the Illinois State Department of Health, establishing an engineering bureau and water and sewage laboratories. He served nineteen months with the A.E.F. during World War I as a Captain in the Corps of Engineers, U.S.A. From 1920 until his death he was a member of the firm of Pearse, Greeley and Hansen (later Greeley and Hansen).

Paul Hansen was an active member of many professional societies and a trustee of Lake Forest College. He is survived by his widow, Allison, a daughter Elizabeth (Mrs. Henry Pope, Jr.), and a son, Capt. Paul S. Hansen of the U. S. Army Medical Corps.

Paul Hansen was elected a member of the New England Water Works Association on January 10, 1912.

KENNETH V. HILL

FRANKLIN HENRY ROBBINS

Franklin H. Robbins, who was Designing Engineer for the Board of Water Supply of the City of New York until his retirement in 1942, died in that city March 12, 1944.

Franklin Robbins was born in Yonkers, New York, August 31, 1872; prepared for Massachusetts Institute of Technology at the Kingston, Mass., High School and was graduated from the Institute in 1894, Course in Mechanical Engineering. After a period of teaching mechanical drawing at the Institute, and one or two other minor engagements, he accepted in 1896 a position rated as transitman on the Western Division of the Boston Water Works, under the superintendency of the well-known hydraulic engineer, Desmond FitzGerald. The writer of this memoir, then an assistant engineer and personal assistant to Mr. FitzGerald, had known Franklin Robbins intimately in Kingston and at M.I.T., and was able to call his availability to Mr. FitzGerald's attention.

In 1898, the Western Division of the Boston Water Works became the Sudbury Department of the Metropolitan Water Works, with Frederick P. Stearns as Chief Engineer and Desmond FitzGerald as Department Engineer. Franklin Robbins was soon transferred to the designing department as a draftsman, a position in which he remained until 1903, when he resigned to accept work with the Burr-Hering-Freeman Commission on the additional water supply for New York. In 1904, he went to Pittsburgh as a designing draftsman in the Bureau of Filtration, a position which he held until 1907 when he returned to New York.

Joining the staff of the Board of Water Supply as an assistant designing engineer, he was promoted through various grades to Designing Engineer in 1927. In this work he had a responsible part in the studies and designs for the Catskill and Delaware River water supply developments, his work including structures for water con-

trol, aqueducts, pressure tunnels and shafts, dams, bridges, aerators, chemical water treatment plants, steel and cast iron pipe lines, and sewage disposal plants.

Franklin Robbins was married in 1899 to Marie La Loge, who survives him, as do two sons, Charles, of Albany, and Henry, of New York; and one grand-child.

Franklin Robbins was a member of the American Society of Civil Engineers, and of the Boston Society of Civil Engineers. He became a member of the New England Water Works Association on Setpember 10, 1897.

CHARLES W. SHERMAN

JOSEPH PALMER WADHAMS

Joseph P. Wadhams, Assistant Chief Engineer of the Connecticut Public Utilities Commission, died at New Haven, Connecticut, on January 17, 1944 at the age of 66. Mr. Wadhams had served with the Connecticut Public Utilities Commission for many years. He was an expert on the valuation of water companies and municipal rates. He also directed the investigation of accidents in which public transportation companies were concerned. Earlier in his career he developed plans for the electrification of the New York division of the New Haven Railroad System.

Joseph Wadhams was a conscientious public servant. For many years he served as secretary of the Connecticut section of the American Society of Civil Engineers and he was a past-president of the Connecticut Society of Civil Engineers as well as a member of the New England Water Works Association. A man of great personal charm, "Joe" Wadhams left behind him many pleasant memories of his courteous dealings and kindly nature.

Joseph Wadhams became a member of the New England Water Works Association on September 17, 1935.

WARREN J. SCOTT

ELTON DAVID WALKER

Elton D. Walker was born in Taunton, Mass., and received his early education in the Taunton public schools. In 1890 he was graduated from the Massachusetts Institute of Technology with the degree of B.S. in Civil Engineering. After three years as a member of the engineering firm of Walker & Gallagher in Chicago, he taught civil engineering from 1894 to 1900 at Union College, Schenectady, N. Y. During his last two years at Union, he was also Resident Hydrographer for the U. S. Geological Survey.

In October 1900, he went to the Pennsylvania State College where he taught until he retired in 1939. From 1906 to 1939 he was head of the department of civil and sanitary engineering. During part of this time he had charge of the operation of the college sewage-treatment plant, and also carried on his researches on open *vs.* closed trickling filters, liquid chlorine *vs.* bleaching powder as a disinfectant for sewage plant effluents, and treatment of creamery wastes.

From 1917 to 1919 Elton Walker served as Captain with the 15th Engineers U. S. Army, and was there engaged in construction which included railroads, water supply, drainage, warehouses, hospitals, barracks, and harbor projects. He was awarded the decoration of the Purple Heart, and a citation by General Pershing "for exceptionally meritorious and conspicuous services with the 15th Railway Engineers at Jonchery and Liffol-le-Grand." After the war he continued his interest in the Army Reserve Corps and became a Colonel of Engineers. He was president of the Centre County Chapter of the Reserve Officers Association of the U. S. and later first vice president of the Pennsylvania Department of that organization.

Elton Walker carried on a consulting engineering practice from 1892 until a few years before his death. His work included sewage-treatment plants, sewer systems, water-supply, and valuation work. He served as expert witness in water-works cases, and as special engineer for the Pennsylvania State Department of Health, he investigated cases of water pollution and applications for permits to construct water-supply and sewer systems.

Besides being a member of the New England Water Works Association, he was a member of the American Society of Civil En-

gineers, the Society for the Promotion of Engineering Education, the American Association of University Professors, and the Society of American Military Engineers. He was also a fellow of the American Public Health Association. In 1926, he called a conference at State College from which developed the Pennsylvania Water Works Operators' Association, and the Pennsylvania Sewerage Works Association. These two organizations started as one, with Elton Walker as the first president.

He was a director of the University Club of State College, and was its president during the construction of the present club-house. He was a member of the vestry of St. Andrews Episcopal Church during the building of the present church edifice, and he took an active interest in the construction of both buildings. He was a member of Sigma Xi, Phi Kappa Phi, Tau Beta Pi, Chi Epsilon, and Scabbard and Blade, honor societies, and of Delta Kappa Epsilon, social fraternity.

In 1896, while at Union College, he married Miss M. Louise Brownell of Schenectady, who survives him. A brother, Chester E. Walker lives in Taunton. Elton Walker had an exactness of memory that was a constant source of amazement to his friends. He had the highest ideals of character and integrity as a citizen, as an engineer, and as a teacher; and his life was a continuous example of these qualities.

Elton Walker joined the New England Water Works Association on November 14, 1906.

LELAND S. RHODES

ROBERT SPURR WESTON

Robert Spurr Weston was born of early New England ancestry on August 1, 1869, in Concord, New Hampshire, the son of Lon and Martha Burtch (Greenman) Weston.

At the age of four or five, his parents established a home in Mystic, Connecticut, and two years later moved to Brockton, Massachusetts, where he had his residence until 1909. Robert Weston's grandfather on his mother's side was the builder of ships in Mystic

and founded the village of Greenmanville, Connecticut. His father was the owner of the Tuck Manufacturing Company, makers of fine tools, in Brockton. Following his marriage in 1909, he made his home in Brookline, Mass.

In 1891, Robert Weston graduated from Amherst College with a Bachelor of Science degree, and received a Master of Arts degree in 1894. During the period from 1891 to 1896 he was a graduate student in chemistry, biology, and sanitary engineering at the Massachusetts Institute of Technology. He studied at the University of Berlin during the winter of 1896-1897. From 1913 to 1916 he was Assistant Professor of Public Health Engineering at the Massachusetts Institute of Technology.

Robert Weston's professional career began as a chemist, and chemistry was always a subject that he greatly enjoyed, and one of those in which he won distinction. One of his earliest engagements was as assistant chemist in the important water filtration experiments and studies at Louisville, Kentucky, in 1895-1896. His fellow workers included George W. Fuller, George A. Johnson, and J. W. Ellms, whose names have since made sanitary engineering history. In 1896-1899 he was associated with George W. Fuller, Consulting Engineer, in New York City, and during 1899, became associated with William Wheeler, Boston, Mass., in private practice, as a consulting sanitary engineer. During the succeeding years his services were widely sought on many sanitary engineering problems.

On January 1, 1916, Robert Weston entered into a consulting engineering partnership with George A. Sampson, his principal assistant engineer, under the firm name of Weston & Sampson, with offices and laboratory at 14 Beacon Street, Boston, Mass. This association was only terminated by his death, and it is probable that few engineering partnerships have continued for over 27 years without any change in the principals and with complete harmony. Robert Weston was truly an ideal partner.

Robert Weston served several states and many cities, towns, corporations, institutions, and individuals, in connection with water supply, water purification, sewerage, sewage treatment and disposal, industrial waste treatment, stream and harbor pollution, and other

public health problems. During the First World War, he was consulting engineer for the United States Shipping Board and the United States Housing Corporation. He was engaged as a sanitary expert in many important cases, including the Chicago Drainage Canal case, the Delaware River case (New Jersey *vs.* New York), and the Connecticut River cases resulting from the takings of the Ware and Swift rivers for the Boston Metropolitan Water Supply.

Robert Weston was co-author of "Waterworks Handbook", by Flinn, Weston and Bogert, published in 1916 with new editions in 1918 and 1927, and author of many technical papers dealing with public health subjects. He was always looking for new and better methods for solving perplexing problems and was recognized by his associates as well abreast of the times. An eminent sanitary chemist has remarked that many of his theories, although considered radical by some, were in fact ten years in the future. He was an early advocate of the filtration of water supplies to improve public health, and their chemical treatment to prevent corrosion of the distribution systems. He was the first to establish the value of pre-chlorination of colored surface sources as an aid in coagulation and filtration. For his studies on lead poisoning and its prevention, in 1920, he was awarded the Dexter Brackett Memorial Medal by the New England Water Works Association. He was also the recipient of the Desmond Fitzgerald Medal of the Boston Society of Civil Engineers.

Robert Weston faithfully attended engineering, chemical, public health, water works, sewage works, and other association meetings of which he was a member, and contributed freely to the discussions. He was an indefatigable reader of technical literature, and readily retained the important facts. In addition to his professional career, he greatly enjoyed social contacts, faithfully attended church, and was fond of music. He was kind, understanding, generous to a fault, and especially helpful to young chemists and engineers in whom he took a fatherly interest. One of his outstanding traits was fairness and his constant purpose to maintain high ethical standards in his profession. He was a man of large stature and commanding presence.

Robert Weston was a member of long standing of the American Institute of Consulting Engineers, American Society of Civil Engineers,

American Institute of Chemical Engineers, American Chemical Society, American Public Health Association (Fellow), American Public Works Association, American Academy of Arts and Sciences (Fellow), American Water Works Association (Honorary Life Member), New England Water Works Association (Honorary Member), New England Sewage Works Association, Boston Society of Civil Engineers, Boston Rotary Club, Boston City Club, and the Society of Mayflower Descendants. He was a former President of the New England Water Works Association, Boston Society of Civil Engineers, and Boston Rotary Club; Vice President of the American Institute of Consulting Engineers, and the Howard Benevolent Society of Boston; Chairman of the Sanitary Engineering Division of the American Society of Civil Engineers, and Director of the American Water Works Association. He served on many technical committees and gave freely of his time and energy.

On December 29, 1909, he married Josephine Fitz-Randolph, of Plainfield, New Jersey, who survives him. There were two children, Elizabeth (deceased), and Joseph Fitz-Randolph Weston, of Waltham, Mass. He also leaves a brother, Lawrence G. Weston, of Brockton, Mass.

Robert Weston was elected a member of the New England Water Works Association on September 8, 1897, and Honorary Member on September 20, 1933.

GEORGE A. SAMPSON

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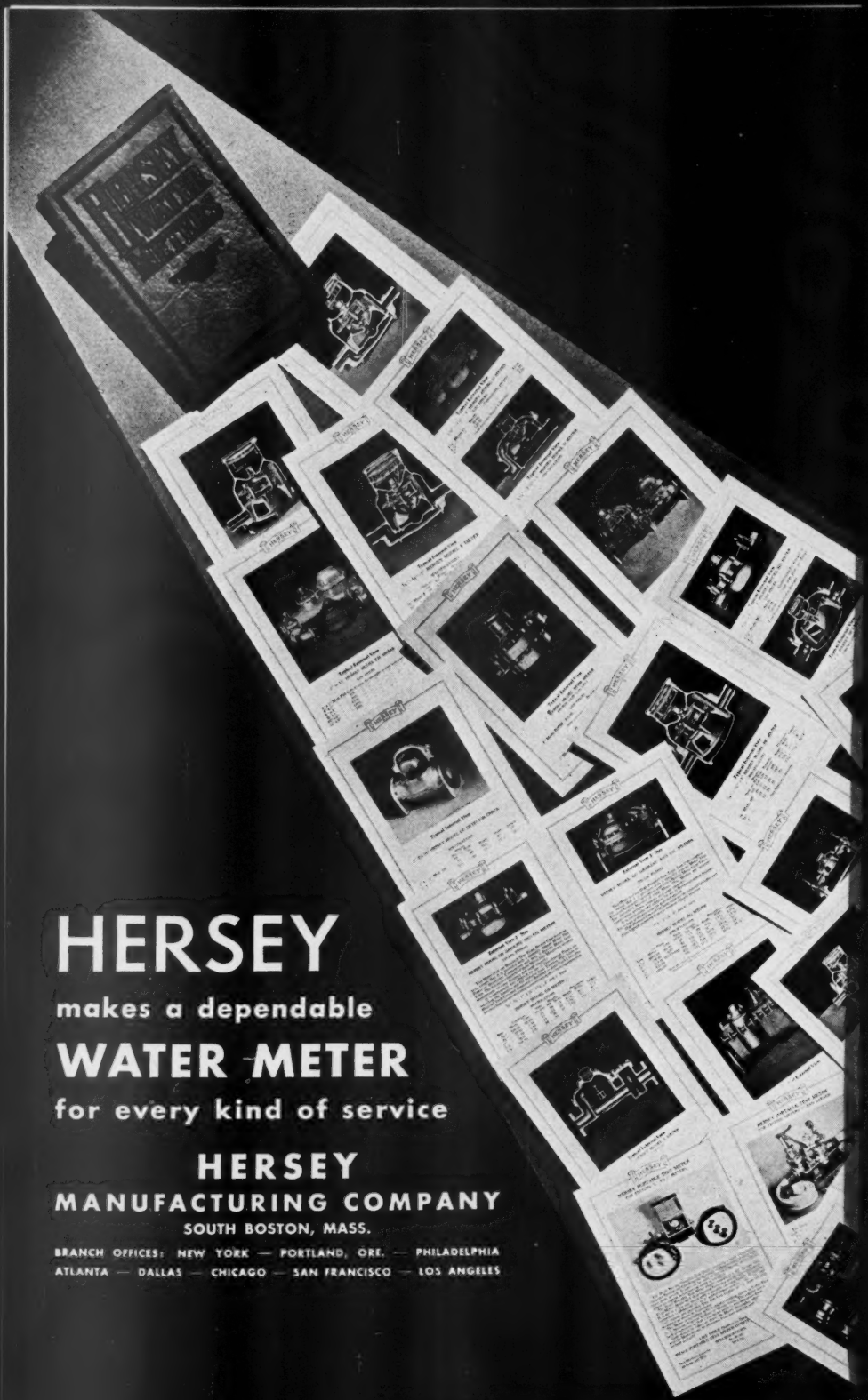

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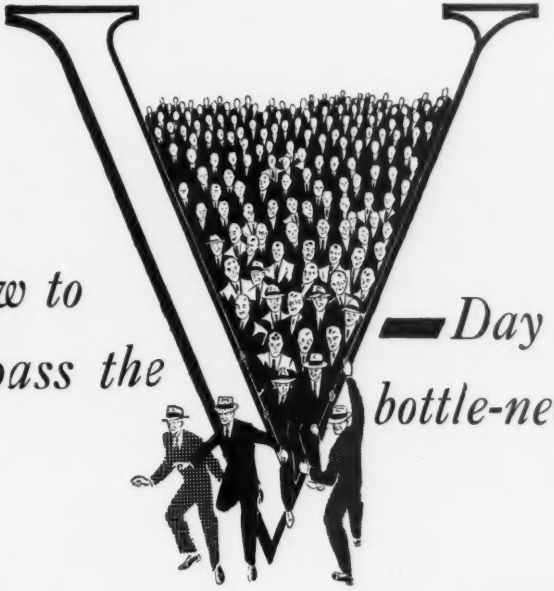

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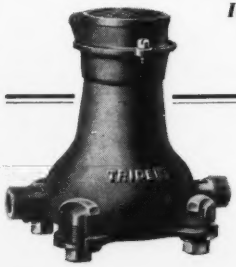

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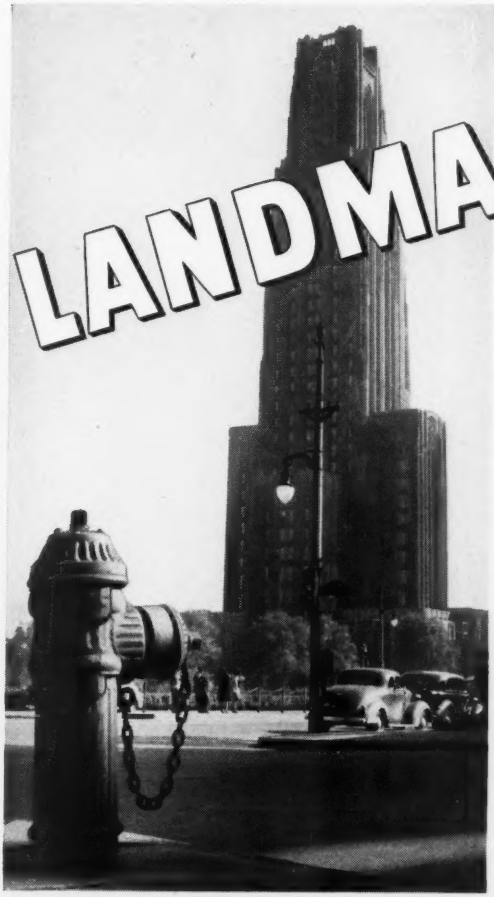

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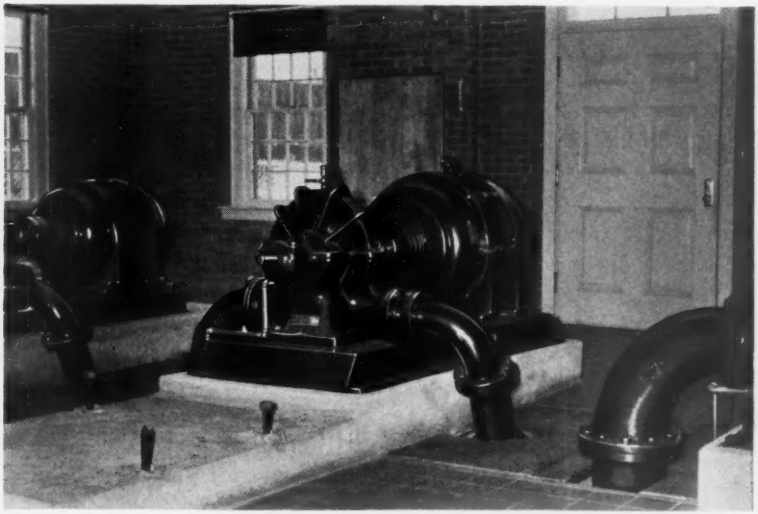

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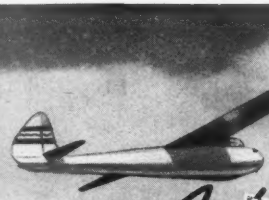

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If the initial cost and the cost of maintenance during the useful life of the Venturi Meter are totaled and averaged, the resulting cost per year is insignificant.

• UNINTERRUPTED SERVICE
The flow through the Tube does not have to be shut off to adjust or repair the Instrument.

• CORRECT INSTALLATION ASSURED
As the Venturi Tube is a complete unit, precisely machined and assembled in the factory, the possibility of inaccurate performance due to faulty or careless installation is eliminated.

• SHORT APPROACH PIPE
Standard Venturi Tubes, having inlet and throat pressure averaging annular chambers and wall-guided flow stream throughout, are less affected by upstream disturbance than are orifice plates, pitot tubes, or conventional flow nozzles. They, therefore, require only a short length of straight approach pipe and permit any kind of fitting at the outlet.

• NO MECHANISM IN THE LINE
The Venturi Tube, which forms a section of the pipe line, contains no inwardly projecting or moving parts.

• SELF-CLEANING
Rapidly accelerating velocity toward and through the throat of the Venturi Tube insures free passage of silt and solids, maintaining a clear interior.

• ACCURACY CAN BE CHECKED
Instrument readings can be verified at any time by comparing with a mercury column or "test pipe" attachment.

• ENDURING ACCURACY
The smooth bronze or stainless steel throat of a Venturi Tube retains its original surface and dimensions, and hence its original accuracy, for years.

For Bulletin 143A describing the construction of Venturi Meter Tubes, address Builders-Providence, Inc., (division of Builders Iron Foundry), 9 Codding St., Providence 1, R. I.

"BLUE PRINT NOW"

Sincerely Yours,

BUILDERS-PROVIDENCE

3 THESE INCHES make all the difference

There is an important difference between the Kennedy Safetop and ordinary fire hydrants. That difference is the Safety Breakable Section.

If broken by a smashing impact, the Safety Breakable Section can be replaced in less than 30 minutes . . . by one man . . . without excavation . . . without interfering with water service . . . at a total cost for labor and materials of less than $10.00. That's quite a saving from a replacement point of view . . . and quite an important advantage from a fire protection point of view. There are many other design features well worth knowing about which are fully described in the Kennedy Safetop Hydrant Bulletin. Write for it today.

The Kennedy Valve Mfg. Co., Elmira, N. Y.

KENNEDY
SAFETOP FIRE HYDRANT
REG. U.S. PAT. OFF.

EDDY

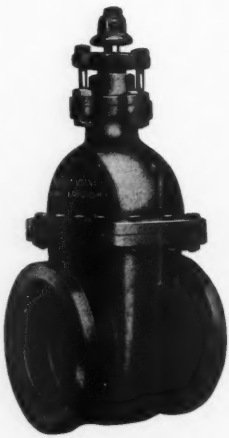
Valves and Hydrants

Distinctive Features of the EDDY Valves

ONLY three parts are moved by the Stem—the ball and the two gates. Each gate is hung from one of the trunnions on the ball. A convex surface at the base of each trunnion fits a concave surface on the back of the gate. This allows the gates to adjust themselves properly to their seats. . . . The gates, being free to revolve on the trunnions, do not always seat in the same position. Gates are center bearing and adjustable. They are forced to their seats with equal pressure at all points. There are two hooks on the ball on sizes 4-inch and larger, which loosely engage with the gates.

Distinctive Features of Our New Swivel Top Hydrants

THIS new hydrant has all the advantages of the popular EDDY fire hydrant, plus several additional features. . . . Nozzles are in a short flanged section of the standpipe, which may be unbolted and turned to different positions. . . . Should the standpipe be broken, only the casting below the swivel head need be replaced. . . . To raise the hydrant to conform to a new grading, simply insert a flanged extension piece below the swivelhead. No digging. To add a steamer nozzle at any time, it is only necessary to replace the swivel head with one having a steamer nozzle.



Besides valves and hydrants to meet the most exacting demands of waterworks service, the complete EDDY Line includes: valves for sewage disposal works; valves for steam, gas and oil; check valves, foot valves, plug valves, shear gates, indicator posts, etc. EDDY valves are made in three classes: Iron Body Bronze Mounted, All Bronze, and All Iron Valves.

Eddy Valve Co.

WATERFORD NEW YORK

WHEN LAYING WATER MAINS TODAY . . .

Remember that joints caulked with lead are soft and flexible . . . take up normal pipe movement without leakage . . . stay tighter longer.

Remember, too, that there is no current shortage of lead . . . no ruling which prohibits the use of lead for caulking purposes.

We furnish lead either in ingot form for cast joints or as lead wool for cold caulking. Both carry the Lead Industries Association Seal of Approval—a guarantee of their purity.

National-Boston Lead Company

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INGOT LEAD — LEAD WOOL — LEAD PIPE
SOLDER — WHITE LEAD — RED LEAD

THERE'S A HEAP LESS TROUBLE

IN LAYING BELL & SPIGOT MAIN with a jointing compound that

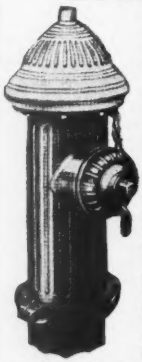
- Can't change its correct chemical composition
- Isn't subject to damage by rain or flood
- Melts quickly and handles easily
- Needs no skilled labor
- Weighs only 1/5 as much as lead and goes three times as far
- Delivers lastingly tight joints with far above the usual resistance to thermal and mechanical shock

WHICH ONE? You *guessed* it!

Tegul- MINERALEAD

The INGOT FORM Compound
for Jointing Bell n Spigot Water Main
For complete information, write
THE ATLAS MINERAL PRODUCTS CO. of PA.
Mertztown - Pennsylvania

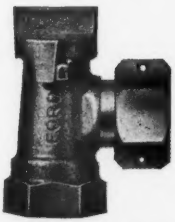
THE A. P. SMITH MFG. CO.,
East Orange, New Jersey



Manufacturers of high-grade specialties in connection with water and gas department work, consisting of—
Machines for inserting valves under pressure, and for making large right angle connections to mains under pressure, and for inserting house service connections under pressure.
Also makers of—
Pipe Cutting Machines, each size being adjustable for use on three different sizes of pipe.
High-grade water works supplies, such as Hydrants, Valves, Meters, Corporation Cocks, etc.
We also make a new type of hydrant which has a breakable joint at the ground line which when struck with an impediment will break at a specified point and only a coupling has to be used to repair the hydrant, which will be back in service in twenty (20) minutes.
"HYDRANT WITH BREAKABLE COUPLING"

SMITH
WATER WORKS SPECIALTIES & SUPPLIES
THE A.P.SMITH MFG.CO. *East Orange,N.J*

Ringstyle



The Ford RINGSTYLE Valve is an inverted key angle valve with meter coupling nut attached. For pit settings where meter is set on risers it makes a most convenient and satisfactory curb valve. Hundreds of thousands in service. Write for catalog and further information.

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WABASH, IND.

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CAST IRON PIPE

. . . AND . . .

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IN WATER WORKS MATERIALS

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HAYS WATER WORKS PRODUCTS
HAYS MANUFACTURING CO., ERIE, PA.
SINCE 1869

That's the range which Morris engineers have combined in this 2-stage, double-suction, series pump.

Three distinct delivery volumes . . . three distinct heads . . . and a top head of 180 feet per impeller!

Maybe you've imagined this couldn't be done without varying the speed and horsepower of the motor. But Morris engineers have turned the trick with a skillful impeller design in a 2-stage, double-suction, series type pump, with 6" suction and 6" discharge. Originally created as a booster pump for an important United States Army water supply, its impellers are so designed that the direct-connected 100 hp., 1760 rpm. motor is not overloaded at the maximum capacity, and yet the delivery is good at the higher pressures, to wit—500 G.P.M. at 360 ft. T.D.H., 1000 G.P.M. at 300 ft. T.D.H., 1500 G.P.M. at 140 ft. T.D.H.

By accurately proportioning the impellers to meet all three performance conditions, Morris hydraulic engineers have again proved their ability to meet the most rigorous demands of wartime use, or reliable, economical municipal operation.

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Baldwinsville, N. Y.

MORRIS CENTRIFUGAL PUMPS

Replacing Old Pumps with New Pays Big Dividends

Many a New England Water Works is operating a pump which, even though not very old, is actually "eating its head off" in power bills.

Consider a typical case:

Rate of pumping—3 MGD **Current cost—2¢ kw/hr.**
Pumping head—231 ft. **5000 hrs. per year operation**
Assumed motor efficiency—88%

	Your Old Pump	*A New 1944 De Laval*
Pump Efficiency	**72%**	**83%**
B. H. P.	**170**	**147**
Electric H. P.	**193**	**167**

Power saved—19.4 kw. at 2¢ rate—38.8 cents/hour
Annual saving—5000 hrs. x .388 equals $1,940.00

A new 1944 DE LAVAL HEAVY DUTY WATER WORKS PUMP, with 150 hp. driving motor and reduced voltage starter, can be supplied for the sum of $2,448.00.

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In many instances the cost can be reduced if your present motor is satisfactory. In such cases the return is much greater.

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of NEW ENGLAND

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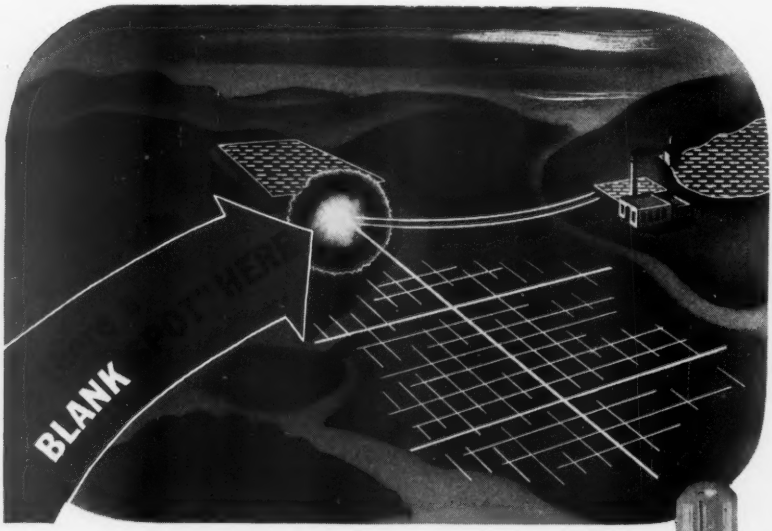
New England Representatives for

DE LAVAL STEAM TURBINE CO., Trenton 2, New Jersey



in the protection you get from Chlorination *?*

● Even though your present Chlorinator installation *produces* a safe water at the treatment plant, can you be sure that this protection is *maintained* in distribution?

Many cities are now making plans to increase their safety-insurance against recontamination at distribution reservoirs, floating reservoirs or finished water storage basins.

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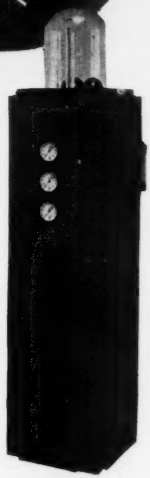
Why not check with W&T engineers on ways and means for eliminating this "blank spot" in 100% protection of water supplies?

"The Only Safe Water is a Sterilized Water"

SA-171S



W&T "VISIBLE VACUUM" CHLORINATOR FOR AUTOMATIC PROPORTIONING OF CHLORINE TO THE FLOW OF WATER

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MANUFACTURERS OF CHLORINE AND AMMONIA CONTROL APPARATUS
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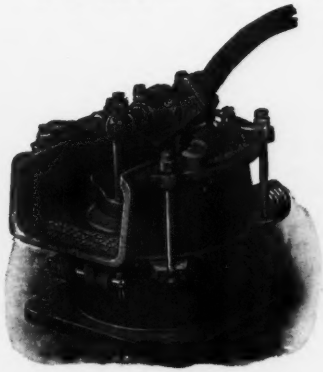
EDSON
PUMPS and ACCESSORIES



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Strainers, Adapters, etc.

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For an Extremely Smooth Pipe Interior

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SPUN **BITUMASTIC** LINING

This Will Assure You of

NO LOSS IN CAPACITY
NO TUBERCULATION OR INCRUSTATION
NO EFFECT ON WATER QUALITY

Recent Repeat Flow Test Shows High Williams Hazen Coefficient Unchanged After EIGHT YEARS

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The most practical way to meet today's overload demand is to clean clogged water mains. FLEXIBLE Underground Pipe-Cleaning Co., specializes in such jobs—any size—2″ to 72″.

RAY BAHR

New England Representative
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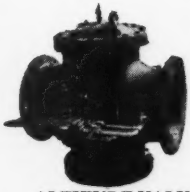
1879—ROSS— 1879

AUTOMATIC VALVES



Controls elevation of water in tanks, basins and reservoirs

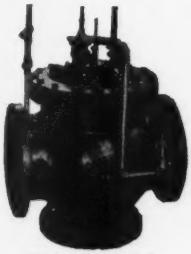
ALTITUDE VALVE

1. Single Acting
2. Double Acting

Maintains desired discharge pressure regardless of change in rate of flow

REDUCING VALVE

Regulates pressures in gravity and pump systems; between reservoirs and zones of different pressures, etc.



Maintains levels in tank, reservoir or basin

1. As direct acting

2. Pilot operated and with float traveling between two stops, for upper and lower limit of water elevation.

FLOAT VALVE

A self contained unit, with three or more automatic controls

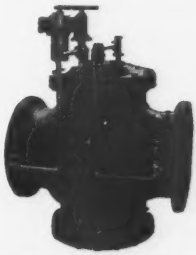
COMBINATION VALVE

Combination automatic control both directions through the valve.

Maintains safe operating pressures for conduits, distribution and pump discharge

SURGE-RELIEF VALVE

Electric remote control—solenoid or motor can be furnished

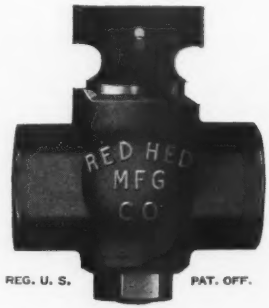


REMOTE CONTROL VALVE

Adapted for use as primary or secondary control on any of the hydraulically controlled or operated valves.

ROSS VALVE MFG. CO., INC. Box 592 TROY, N. Y.

"BLUEPRINT NOW!"



DO NOT CONFUSE *COST* WITH *ORIGINAL PRICE.* *COST* IS ORIGINAL PRICE, PLUS MAINTENANCE DURING LIFE OF ARTICLE, DIVIDED BY NUMBER OF YEARS OF SERVICE.

RED HED MFG. CO.

Manufacturers of

RED HED Brass Goods for Water Works

368 Congress Street Boston, Mass.

..at Newport, Rhode Island

%PROPORTIONEERS% EQUIPMENT IS SERVING SWANK NEWPORT AND ITS IMPORTANT MILITARY ESTABLISHMENTS

Four hydraulically operated manually controlled %Proportioneers% Chem-O-Feeders, illustrated above, are installed in the chemical feed room at the new Lawton's Valley Plant of the City of Newport where they are feeding aqua ammonia for taste and odor control with conspicuous success. The 26° BE aqua ammonia is forced by compressed air from a 500 gallon underground storage tank into three individual fume-proof dilution tanks, shown above, where it is diluted with water, 9 to 1 in one of the tanks, and 18 to 1 in the others. One Chem-O-Feeder is used for pre-ammoniation and two for post-ammoniation of the discharge from 1400 and 2800 gallon per minute pumps. The fourth feeder will soon be in use feeding Calgon to the plant effluent for corrosion control.

%Proportioneers% is prepared to handle your postwar ammoniation and Calgon feeding problems, whether your plant is smaller or larger than the Lawton's Valley Plant at Newport which is now operating at four and a half million gallons per day. Write today for our recommendations.

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LIST 340

Clearway Quiet-Closing Check Valves eliminate "SLAM"

Made in straight-thru type, as well as expanding outlet type for bolting direct to pump discharge.

Write for Bulletin V-1

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Herbert H. Crowell, *Sales Mgr.*

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RELINING RESERVOIRS - TANKS

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FOR

Water, Steam, Gas and Culverts

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WORCESTER, MASSACHUSETTS

Printers to
THE JOURNAL OF THE NEW ENGLAND WATER WORKS ASSOCIATION
and *other* good publications.

WHEN THE CALL COMES
MATHEWS ARE READY!
There is no need to worry over hydrant-failure — that nightmare to many a fire department — when you install Mathews Modernized Hydrants. Their construction is simple and rugged, requiring little attention and repair. When a traffic smash or other cause makes it necessary, they are easily and quickly replaced without digging or breaking pavement. Two men in 15 minutes can unscrew the damaged barrel containing all the working parts and put a new one in its place. Mathews Hydrants not only give your community more dependable protection, but they enable you to cut maintenance costs to the bone. Make it a point to include Mathews Hydrants in your post-war plan.
MATHEWS HYDRANTS
400 CHESTNUT STREET, PHILADELPHIA, PA.
ESTABLISHED IN 1865
Made by R.D. WOOD Company
MANUFACTURERS OF SAND SPUN PIPE (CENTRIFUGALLY CAST IN SAND MOLDS) AND R. D. WOOD GATE VALVES

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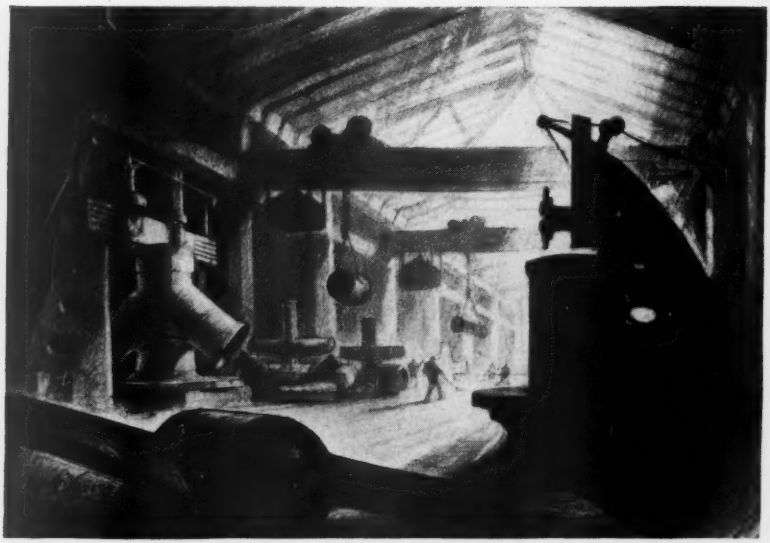

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